DOCUMENT RESUME

ED 409 453 CE 074 402

TITLE	Technology-Supported Learning (Distance Learning). Report No. 1253.
INSTITUTION	Ministry of Education, Copenhagen (Denmark).
REPORT NO	ISBN-87-603-0415-4
PUB DATE	93
NOTE	158p.; Translated and edited by Peter Olaf Looms.
AVAILABLE FROM	Ministry of Education Publishing Office, Frederiksholms Kanal 25F, DK-1220 Copenhagen K, Denmark (150 Danish kroner).
PUB TYPE	Reports - Research (143)
EDRS PRICE	MF01/PC07 Plus Postage.
DESCRIPTORS	Adult Education; Comparative Analysis; Computer Uses in Education; Conventional Instruction; *Distance Education; Educational Change; *Educational Finance; *Educational Needs; Educational Policy; *Educational Technology; Financial Support; Foreign Countries; Independent Study; Lifelong Learning; Models; Position Papers; Program Development; Strategic Planning; Tables (Data); *Technological Advancement; Teleconferencing
IDENTIFIERS	*Denmark

ABSTRACT

The Danish government asked a committee of experts to describe the problems and opportunities posed by the use of new technologies in Denmark's education system during the 1990s. The committee began by examining Denmark's educational system within the context of changes in the workplace, the economy, and technology. Three scenarios were developed that, together, constitute a framework for technology-supported learning: the time-independent learning model (learners study at home or in the workplace and maintain a continual dialogue with teachers and other learners); the simultaneously distributed learning model (learners can, thanks to satellite systems and videoconferencing) see and hear their teacher and carry on a dialogue with a teacher while studying individually or in groups); and the independent study model (students work alone with subject matter in an organized sequence of modules). The economic consequences of each scenario were analyzed and compared with those of traditional methods of educational provision. The committee concluded that technology-supported models of learning are well suited to meeting a substantial part of Denmark's future needs for lifelong education. (Twenty-four tables/figures are included. Appended are the following: terms of reference, composition, and calendar of the committee and agendas of two seminars conducted by the committee.) (MN)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

ED 409 453

Undervisningsministeriet

Technology-supported learning (Distance Learning)

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)
☐ This document has been reproduced as received from the person or organization originating it.
☐ Minor changes have been made to improve reproduction quality.
• Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

CE074402

PERMISSION TO REPRODUCE AND DISSEMINATE THIS MATERIAL HAS BEEN GRANTED BY
P Billesoe
TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

BEST COPY AVAILABLE

Technology-supported learning (Distance learning)

Report No. 1253

Danish Ministry of Education

Technology-supported Learning
(Distance Learning)

Report No. 1253

ISBN (this volume) 87-603-0415-4
Translated and edited by Peter Olaf Looms
(committee member)

ISBN (original Danish set) 87-603-0321-2

Printed in Denmark by: Malchow, Ringsted

Price of this volume: 150 DKK.

To order, this volume UVM 4-008, contact the
Ministry of Education Publishing Office,
Frederiksholms Kanal 25F, DK-1220 Copenhagen K.
Telephone: +45 3392 5220.

List of contents

FOREWORD *5*

SUMMARY *6*

PREFACE *18*

CHAPTER 1
THE EDUCATION SYSTEM IN THE NINETIES - NEW QUALIFICATIONS FOR ADULTS *21*

CHAPTER 2
THE ECONOMICS OF THE EDUCATION SYSTEM IN THE NINETIES *29*

CHAPTER 3
TECHNOLOGY-SUPPORTED LEARNING IN THE NINETIES - FOR WHOM AND HOW *55*

CHAPTER 4
SCENARIOS FOR TECHNOLOGY-SUPPORTED LEARNING TOWARDS THE YEAR 2000 *81*

CHAPTER 5
THE WAY AHEAD TOWARDS THE YEAR 2000 - PROPOSALS AND RECOMMENDATIONS *137*

APPENDIX 1
THE TERMS OF REFERENCE, COMPOSITION AND CALENDER OF THE COMMITTEE *147*

APPENDIX 2
AGENDAS OF TWO SEMINARS HELD BY THE COMMITTEE WITH THE PARTICIPATION OF A BROAD CROSS-SECTION OF INTERESTED PARTIES *151*

LIST OF FIGURES *154*

LIST OF TABLES *156*

Foreword

We are living in a society characterised by rapid change. This applies to all sectors of public life. These rapid changes simultaneously present us with major challenges on two fronts: while adapting to new societal requirements on the one hand we have to ensure that good qualities of the present system are not lost in the process.

Adaptation is a difficult process. Decisions have to be based on a solid, well-researched foundation in order to be successful. This also applies to the prospects of increasing the use of new information technology and telematics in the education sector. Even though education is predominantly a national matter, many of the problems that will arise are global. Not only does this apply to technical issues, but also to many organisational and pedagogical problems common to all which transcend national frontiers.

The Danish government asked a committee of experts to describe the problems and the opportunities that new technologies facing the education system in the course of this decade. A thought-provoking report has been the result. This is the main volume of the report which has been translated into English. It is a Danish contribution to the recognition and solution of problems confronting the education sector in many countries all over the world.

Ole Vig Jensen
Minister of Education

Summary

The societal background

We are living in a society characterised by rapid change and in which the need for education and training is ever increasing. In a global economy, the division of labour is increasingly international, the location of manufacturing and services being determined by quality and competitiveness. At the same time, it is a truism to say that technological development is accelerating at such a pace that most of the technology which will be in use in 10 years' time has yet to be developed. Nevertheless, at least 80 per cent of the present workforce will still be active in the year 2000.

The pace of development and the increasing demand for knowledge will require great flexibility on the part of the workforce, as it will have to adapt continually to the demands of changing, or totally new jobs. In order to meet these demands, education will have to become a lifelong process in the future.

It is, however, insufficient that the individual be ready to adapt, and that he be motivated to learn. A fundamental reorganisation of the education system will also be needed.

Our education system - from the primary and lower secondary school (the Folkeskole) to higher education - is first and foremost a coherent set of self-contained educational provisions for young people. Among other things, this is illustrated by the fact that expenditure on adult education still only accounts for 11. 8 per cent of the total education and training budget in Denmark. Be this as it may, educational institutions have increasingly taken on new tasks in relation to new target groups, and in this connection have developed novel teaching methods involving the application of new technologies.

If we are to sustain our standard of living in the long term, we must be prepared to increase the pace with which we adopt new technologies. With the introduction of new technology not only in manufacturing but also built into the products themselves, production will both embody more knowledge and and demand greater knowledge.

If we are to satisfy the needs that technological development brings with it, the education system must be restructured so that the provision and implementation of lifelong education and training becomes a significant part of its priorities. At the same time, educational institutions must be prepared to engage in technology-supported learning in cooperation with partners outside the traditional education system. New technology-supported learning systems - with their potential for tailoring courses to the needs of the students, for the delivery of courses to the student's home or workplace and at times convenient to the students - will be able to further significant elements of this reorganisation of education to support a flexible, lifelong learning pattern. Furthermore, they will constitute an integral part of overall initial education and training provisions.

Economic Trends in the Development of Education and Training

In Denmark, education and training accounts for about 7 per cent of GDP and about 26 per cent of public sector operational and investment budgets. As salaries account for just under 80 per cent, the education sector is extremely labour and salary-intensive compared with most other sectors of society.

For a number of years, commodity prices have risen at a lower rate than wages. The fact that this has been possible is attributable to productivity gains resulting from an increased use of new technology in manufacturing.

Given that teacher salaries increase at the same pace as in society at large, costs in the education system - and thus the "price" per student - will increase more rapidly than the costs and prices elsewhere.

The reason for this is in part due to the fact that the education sector is comparatively labour-intensive, and in part due to the fact that opportunities for productivity increases are limited, given the current organisational structure of educational provisions.

Simply to maintain current educational standards, we shall thus have to pay more for education and training in the future. The committee has calculated that, if student numbers and educational standards remain unchanged, expenditure on education and training at constant prices will increase from approximately 57 billion DKK per annum in 1990 to about 66 billion in the year 2000 merely as a result of salary increases. Total additional expenditure for the ten-year period will be approximately 50 billion DKK.

It is open to question whether such "natural buoyancy" in expenditure will be acceptable, or whether demands will be made that educational staff should balance gains in their real remuneration with productivity increases, as is the case with other groups in society.

Meeting such productivity demands coupled with demographic factors will, however, have the side-effect of accentuating the trend to close down small institutions in thinly-populated areas.

It is also by no means clear whether the education sector with its current organisation of educational provisions will be able to achieve the required productivity gains without an unacceptable reduction in quality.

On the other hand, there is the possibility of adopting new technology-supported learning methods.

Technology-Supported Learning

The committee has chosen to define technology-supported learning as any form of study where the teacher and students are not present on the same premises, and where study is systematically and deliberately supported by technology. The concept furthermore includes forms of study which are supported by technology, leading to changes in the role of the teacher from that of having control over the learning situation to one in which it is the student who assumes responsibility for his studies and the teacher acts as a consultant, as and when the student feels the need for it.

Study traditionally takes place at the same time (the timetabled lesson) and in the same place (the classroom). As opposed to this, technology-supported learning may take place at different times and in different places. In addition, technology-supported learning leads to significant changes in teacher and student roles. The committee has, however, emphasised that the courses must have an explicit, pedagogical structure, and that to a certain extent study must be supported by a dialogue between the teacher and the student and/or among the students themselves.

Three scenarios

Taking as its point of departure typical study situations, three scenarios have been contructed. Together they constitute a framework for technology-supported learning which - in the opinion of the committee - when used individually or in combination, will cater for substantial areas of the Danish education system over a ten-year period. The three scenarios are as follows:

- The time-independent learning model
- The simultaneously-distributed learning model
- The independent study model (differentiated learning).

For each scenario, calculations have been made which show the economic consequences of that model compared with those of traditional provisions. The costs of both traditional provisions and of the scenarios have been projected on the basis of technology options and trends as we know them today. At the same time, it is assumed that new technology-supported learning modes are applied rationally and are in everyday, mainstream use. In the scenarios, the assumption is also that the cost-intensive development phase has been completed and that the inevitable "growing pains" are over.

In the case of the *Time-independent Learning Model*, one can combine elements from classroom teaching with the temporal flexibility of the correspondence school. The individual student studies at home or at his place of work, from where there is a continual dialogue with the teacher and with the other students.

Typically this model employs a computer conference system, communication being mediated technically via a modem which is connected between the telephone and the student's personal computer.

In Denmark, the distance learning dimension, where students work on their own or in groups, is normally combined with classroom teaching in the form of a limited number of weekend seminars.

The model is well-suited to time-independent learning. Weekend seminars aside, it is independent of distance. The time-independent learning model is not, however, particularly flexible when it comes to the starting date and variations in study load during the course.

The model makes relatively big demands on the student's maturity, motivation and his ability to work independently. Compared to traditional teaching, the course involves predominantly written rather than oral communication. The time-independent model makes great demands on the planning and pedagogical quality of the course, and highlights the performance of the individual teacher and that of the teacher group.

As it is a relatively labour-intensive study mode, such courses will have a built-in cost buoyancy, albeit less pronounced than that of traditional courses.

Based on the committee's calculations, the time-independent learning model becomes cheaper than traditional direct teaching with student/teacher ratios of 20 or more, depending on the conditions. The bigger the student/teacher ratio, the greater are the advantages of the time-independent model. With 100 students, the costs per student for this model are about 31 per cent lower than the costs in a comparable traditional provision. These benefits have not been achieved in experiments to date, all of which have been small-scale, but they will be feasible in the event of a change-over to large-scale, rational and mainstream operations.

In the *Simultaneously-Distributed Learning Scenario*, students can see and hear their teacher. They can also carry on a dialogue with a teacher when studying either individually or in groups. Technically, the model builds on satellite, cable television or on video telephony (video-conferencing).

The model offers the opportunity of linking the teacher in a classroom or studio to one or several classrooms at different geographical sites.

Of the scenarios described, the simultaneously-distributed learning model is the one which is closest to the traditional teaching mode. Therefore, neither the student nor the teacher roles are significantly different from those of traditional provisions.

This model requires that teaching takes place at dates and times which have been agreed in advance. The model is good at overcoming the barrier of distance, and it is therefore well-suited when it comes to serving thinly-populated areas with a few, small institutions, where it is difficult to assure reasonable class sizes. By coordinating and combining the teaching of small classes, the range of courses from which the students can choose can be broadened. It is, furthermore, well-suited as a means of promoting specialisation among educational institutions in various parts of the country, and for the education and training of those involved in research.

As the equipment used - typically video-conferencing - is relatively expensive, study normally takes place at an educational institution or at the student's place of work.

As regards the start and the progression of such a course, the model corresponds to traditional provisions.

Given the current situation, it is not economically advantageous for institutions to offer entire courses based on video-conferencing technology. But the use of such technology has economic advantages, if the teaching of small classes is coordinated and combined.

As significant reductions in the prices of the hardware used in the model are forecast, the example on which the committee has based its calculations, (an entire higher commercial examination course), will become cheaper than the corresponding traditional provision by the year 2000, if it is implemented in the form of simultaneously-distributed learning, and if the educational standard of the traditional provision remains unchanged.

In the last scenario - the *Independent Study Model* - the student, in principle, works alone with the subject-matter in an organised sequence of modules. The student also works at his own pace, and he must be able to find answers to all his questions in the study package. As the last condition is difficult to fulfill, in practice the model will frequently be supplemented with the

option of counsellor support at a study centre.
Breakthroughs with regard to videodiscs and CD-ROM technology leading to a rapidly increasing supply of high-quality material for independent study can be expected in the coming years. As the number of units sold in the international market will be high, the price of independent study packages can be expected to drop significantly.

In principle, the model can operate with unlimited class quotients. In practice, however, it is often the case in Denmark that independent study materials are used in study situations where there is still a teacher present, and where independent study is combined with traditional teaching. In these delivery modes, the teacher role changes into that of consultant; the teacher becomes a human resource, to whom the students can turn as and when they wish.

Even in the last instance, the model is economically advantageous, as the teacher - depending on the quality of the teaching material - can handle larger classes than he would otherwise be able to in traditional provisions, and because the duration of the course can be reduced by about a third. To this should be added that course participants have proved better at coping with their final examinations than the participants in the traditional provisions.

The independent study model makes great demands of the autonomy of the students. At the same time, the teacher role is radically different. In this mode, the teacher functions as a counsellor and offers support in connection with the students' acquisition of study skills. In addition to this the teacher will, if necessary, have to put together study units using multimedia materials.

The Recommendations of the Committee
Technology-supported modes of learning are well-suited to meet a substantial part of future needs for "lifel-

ong learning". At the same time, technology-supported modes of learning make it possible to maintain and extend the geographical distribution of education and training provisions. For these reasons, in conjunction with projected trends for the cost of technology-supported learning compared with traditional provisions, the committee recommends that a coordinated initiative with well-defined objectives should now be implemented with the aim of extending technology-supported learning provisions in Denmark.

The committee thus proposes the following:

1. All interested parties within and outside the public education system should have the opportunity of participating actively in the development of technology-supported learning provisions, including provisions leading to formal educational qualifications. In this connection,existing education and training monopolies should be abolished, and all citizens should be given the right to present themselves for publicly recognised examinations, even though they are not enrolled in a course at an educational institution. Public study grants linked to a unit/credit scheme do not seem to constitute an obstacle to a liberalisation which is both characterised by competition and which, at the same time, maintains quality criteria in the form of examinations. There will also be significant opportunities for fruitful cooperation between educational technology specialists, adult and further education, and traditional educational institutions. Such cooperation will increase the pace at which professional expertise in the use of technology support modes of learning is acquired by those offering full-time courses of education.

2. An in-service continuing training programme should be initiated for both teachers and administrative staff who are to take part in the organisation and implementation of technology-supported learning. This programme should be of a temporary nature until existing teacher training provisions have been able to

integrate the necessary skills required to offer technology-supported learning programmes. The in-service programme should aim to train a sufficient number of staff in order to establish a core of expertise at the institutions involved; the committee envisages something of the order of 15-20 per cent of the teaching profession taking part in such a course. In the first phase, the target group should be schools of vocational education and training, and institutions of higher education.

The breadth of the course should be such that it gives an understanding of all the scenarios which have been described in this report, and the course organisation must include practical exercises. The course should be technology-supported in part, so that the course participants have the opportunity to gain first-experience of these study modes.

Furthermore, the course should be organised so that it caters for all categories of teachers. The development of the course should involve both companies and organisations with experience in technology-supported learning and educational institutions with well-documented expertise in the pedagogical in-service training of the target groups in question.

At the same time, existing teacher training programmes and a number courses in administration should be reorganised so that in initial education and training provisions it becomes possible to acquire professional competence within the area of "organisation of technology-supported learning".

3. Funds should be earmarked from public building and equipment appropriations for full or partial grants for the purchase of equipment for technology-supported learning. Such grants should only be made for initial purchases.

4. A joint national data network should be used which

institutions can join for a limited period of time free of charge, and which provides a series of specific services, including the operation of a conference system or other kinds of electronic systems which facilitate network cooperation among several users. The service should be supported by a unit responsible for service and maintenance,upon which the participating institutions can draw. The operation of the network should be supported by public funds. Support should also be given to students' use inasmuch as they should only have to call the nearest network node and thus pay the local telephone rate.

5. Legislation pertaining to radio and television should allow for the use of the public broadcasting network for the transmission of educational programmes and data. In addition, the possibility of educational institutions or the Electronic University (see below) using the broadcasting network and retaining intellectual rights to the educational materials themselves should be investigated.

6. A national service centre for the development of technology-supported learning should be established. In order to guard against the development of an organisation with its own institutional interests, the committee envisages a small organisation along the lines of the Danish Research Academy which could act as a dynamo and function as a source of inspiration. The committee makes the assumption that a considerable part of the tasks will be delegated to the education system. In addition, the centre will be given tasks relating to the drawing up of development contracts, course schedule monitoring, the acquisition of national licences, the importation of foreign teaching materials, copyright issues and the like.

Consideration should be given to the question of letting the centre be responsible for the dissemination of information about, and the organisation of, distance education provisions,in particular those forms corresponding to the time-independent learning model. In this connection, the centre should be entitled to receive government "taximeter" grants (i. e. grants per enrolled student) and subsequently settle accounts with the participating institutions on the basis of contracts entered into.

The centre should have a life of ten years. Before this period expires, the future of the centre should be assessed with a view to either closing it down or changing its terms of reference and maintaining it in a scaled down form. We propose that the centre be called "the Electronic University".

7. Partial or total funding should be made available for the adaptation of a number of traditional courses to include technology-based learning. There should be a broad range of courses organised in this way, to cater for those who would no doubt prefer this learning mode, if it were generally available.

The aim of supporting such developments, possibly in the form of co-financing agreements, should be to ensure the creation of a broad and coherent educational provision within a period of a few years. This would also enable institutions to offer a wide and varied range of education and training, in particular in the field of formal, vocationally-oriented adult and further education in geographical areas where their location makes it difficult to offer traditional courses.

Preface

The working procedures of the committee

The committee was set up at the end of 1991 started work in 1992 and conducted its work for just over 18 months. In accordance with its terms of reference, the committee was to list a number of foreseeable scenarios for the increased use of technology support in education, with specific reference to adult and further education.

Unlike most other studies carried out in this field, the terms of reference of this committee stressed economic dimensions in the description of the scenarios. The latter were to be compared with traditional provisions, and it was a condition that the net impact of the scenarios on educational budgets was to be neutral for a given period of time. The concept of budget-neutrality might, however, include a wide range of social cost structures, and the committee was thus not obliged to restrict its analysis to traditional cost structures in education and training. The committee has not, however, made use of such social cost structures, as their inclusion would have made demands on the work of the committee beyond its resources. The approach adopted has therefore been the traditional one - educational and training costs seen from the point of view of the supplier.

When educational provisions are reorganised to make use of technological support, pre-produced study materials often constitute an integral part of the course. Such study materials may take the form of video cassettes or television programmes. They may also take the form of interactive educational programs distributed on diskettes or via a network. In many cases, distribution may involve copyright payments, and these may be substantial. Copyright issues are very complex, and the costs almost impossible to estimate in a scenario. The committee has therefore chosen not to deal with copyright issues in its work but draws attention to the fact that intellectual property is a central problem which should be examined in more detail.

Most analyses of technology-supported learning either apply a technical approach (Which learning technologies are relevant?) or an organisational one (How do we organise cooperation with regard to the development and delivery of technology-supported learning?).

The economic dimension had only been studied to a limited extent at the beginning of the committee's work, and there were few international studies to use as a starting point. The economic dimension has now also claimed international attention.

The members of the committee were appointed in a personal capacity and have participated actively in the writing of the report in their respective professional fields.

As the focus was an economic one, the economist on the committee was asked to interview people from a number of organisations which had either carried out isolated experiments on the use of technology support in education or who were using different kinds of technology support for parts of their courses on a regular basis. The descriptions are thus an economist's view of the world of technology-supported learning.

It soon became clear to the committee that the subject was so comprehensive that, if all facets were to be treated in depth, the actual report might end up being lengthy and perhaps unintelligible. The committee therefore chose to divide the responsibility for the exhaustive expert descriptions among the members and include them in a number of appendices. Each appendix appears under the writer's own name, and the points of view expressed do not necessarily reflect the opinion of the committee as a whole.

The committee has discussed a number of scenarios which are described in chapter 4 of the report. On the basis of these, the committee's economist has worked on a great number of variations of the scenarios. There are both variations in the technical configurations of the individual scenarios and sensitivity analyses within individual configurations. The committee has not had the possibility of conducting detailed analyses of this comprehensive material and has therefore limited itself to selecting a few examples which have been included in the report, because they illustrate the economic structure of each of the scenarios. Neither has the committee considered a number of personal communications which are included in the appendices mentioned earlier.

In the course of its work, the committee has held two seminars with a wide range of interested parties - suppliers, users and professional organisations. The opinions expressed at these seminars have constituted an invaluable input for the work of the committee.

For many, technology-supported learning is an unknown phenomenon, whose many different forms or modes are difficult to explain by means of words. The committee thus commissioned the production of a video cassette which describes the proposed scenarios with reference to a number of Danish examples.

Details of the composition, terms of reference and meetings of the committee as well as summaries of the two seminars appear in appendix 1 and 2.

The committee hereby considers its work concluded.

CHAPTER 1

The education system in the nineties - new qualifications for adults

1. 1. The transformation of society

1. 1. 1. Much has been written in recent years about the importance of education as a competition parameter in the nineties. Among the most significant works which cover both the European and the Danish situation is a report from the European Community's Industrial Research and Development Advisory Committee (IRDAC), "Skills Shortages in Europe" and the Zeuthen committee's report, in particular Appendix 4: "Capacity and needs in the continuing and further education and training system". Characteristic of these reports and others on the same issue is the consensus regarding trends.

The IRDAC-report starts by noting that the decades since World War II have been a period of rapid and accelerating technological change fuelling increased industrial productivity and economic growth. The regional markets we were used to in the past have now become global, as has competition. Competition is fierce, and the margin between success and failure is narrowing all the time. The new information age is often termed the global village, although half-timbered cottages and hollyhocks are few and far between, and there is definitely no room for Sleeping Beauty!

1. 1. 2. In global terms, there is a great difference between the market conditions for low-technology products and for high-technology products. For low-

technology products, price is the deciding market factor, and areas with low labour costs are thus apparently at an advantage. Jobs which are primarily linked to the production of low-technology products are therefore constantly in danger, as they run the risk of being moved at a short notice to another country or part of the world, where manufacturing costs are lower.

It is not strange that the world has changed since the Second World War. The crucial difference is, however, the *rate of change* which we are now witnessing in all areas. The competitive stakes for high-technology products increase all the time. Product innovation is to a considerable degree the driving force behind this market. Companies with a leading position are, indeed, investing considerable sums in applied research. It is characteristic that the competitive lead which an invention gives a business in relation to its competitors is getting shorter all the time, and the risk of making erroneous investments is alarmingly high. It is thus imperative to work rapidly - some would probably characterise it as feverishly - with process innovation to incorporate the latest knowledge into one's products in order to increase market share before one's competitors do so.

The IRDAC report [page 16] describes the situation as follows:
"The current and sustained wave of rapid technological change is probably without historical precedent. The impact of technological advance is felt in all aspects of society, and notably on employment patterns. "

1. 1. 3. At the same time, manufacturing is currently undergoing qualitative changes. For periods of several years in the industrialised world during the 1970s and 1980s, one could observe new, large-scale investments in production systems employing information technology and at the same time marginal or even negative productivity gains as the result. There are many hypotheses to account for this phenomenon, one of them being that the need for continuing education and trai-

ning hand in hand with investment had not been recognised, neither had the impact of new technology on the way work is organised been taken fully into account.

This problem now seems to have been solved, and productivity is rising again. On the other hand, it now appears that keen competition forces companies to stake a great deal on productivity-lead growth. The price of survival for a business in the manufacturing sector therefore seems to be the adoption of the following model: increased investments in new technology, increased productivity - and fewer employees. This is why there is currently a common concern at political level in the Western world that society is developing into one in which two thirds of the population by and large are unfamiliar with unemployment, while the remaining third generally speaking have no experience of work.

1. 2. Towards lifelong learning

1. 2. 1. It might sound like a nightmare, but the economy has been through this process before. Agriculture has been through the process in the past. A country based on crafts was transformed into an industrialised nation. And now society based on industry and services is on its way to becoming what one could term the *network society.* This will be a completely different place with totally new job categories. It will be characterised by new working methods, new ways of life with new ways of being together and talking together. New means of learning will come into existence.

Apparently what we have here is a change which is taking place so rapidly that it would be better characterised as a revolution. Furthermore it is probably a revolution which will transform the role of education and training in society.

The IRDAC report [page 39] describes the challenge with reference to the following paradox:

"Though most of the technology that will be used in 10 years' time still needs to be developed, by [the year] 2000, at least 80% of the current employees will still be part of the labour force. IRDAC believes therefore that a substantial proportion of the corrective action should go to this group, in particular towards its older part which is lower qualified and which came on the labour market before the technological changes [took hold]. Given the decreasing supply of young people (though on the average better qualified) and the pace of technological change, a massive investment in upgrading of the existing workforce will be needed. "

It will thus require great flexibility on the part of the present workforce to have to adapt continually to the demands of rapidly changing, or maybe totally new jobs. IRDAC states unequivocally that *"updating and retraining should be considered not only as a right, but as a need and a social duty.* "[page 40]. If this is not recognised by the individual, the labour market and public authorities alike, many will risk having to adopt the flexibility to which the marginalised third of society is already exposed to today,i. e. the requirement of being flexible when it comes to being embraced and then shunned by the labour market!

1. 2. 2. Education and training will become a lifestyle. This is not the same as saying that one has to go to an institution and sit at a desk to learn throughout one's life. There are, and have always been, many other ways. For instance, on-the-job learning has always been an important way of learning. With new technologically-based forms of communication, the concept will be given a totally new meaning and will no doubt become increasingly important in the future.

Lifelong learning will be necessary if one wants to remain in, or rejoin, the labour market but that is not all. A world in flux is also an insecure world. The importance of lifelong learning also lies in the opportunity to help the individual understand what is happening to himself and to the society of which he is a part. The opportunity given by education and training for a social life, shared experiences, the feeling of success and the joy of experiencing something will, for many, be just as important as purely work-related continuing education and training. This applies in particular to the unemployed who often feel defeated, having being rejected by the labour market. This is the same feeling of defeat which many of the unemployed also experienced earlier in life in their encounters with the formal education system.

1. 3. The changing nature of adult education

1. 3. 1. What has characterised the education system to date is that children and youth are given a long formal education which emphasises socialisation and the acquisition of methods, study skills enabling them to "learn how to learn". This lengthy course of education in their formative years is a strong affective influence. Young people learn to take a stance on given issues and to evaluate the information with which we all are bombarded in our daily lives. In addition to this ballast of methods and attitudes often termed general qualifications or skills, long post-compulsory courses of education provide students with a number of job-specific tools and skills, the aim of which is to enable them to gain employment.

Both the individual and society have so far been of the opinion that this initial ballast was a sufficient foundation for the rest of their lives. Continuing education and training have therefore primarily focused on the need for short courses, often of a few days' duration, during which new working methods or production techniques could be learned.

1. 3. 2. This description is both right and wrong. It is correct in the sense that the description fits many of the job-related continuing education and training provisions. But one should not forget that Denmark has a long and proud tradition of voluntary leisure-time

education, where like-minded adults meet to study subject-areas of common interest. They study languages, mathematics, psychology, discuss social affairs, in short take part in general education. Courses typically stretch over a considerable period of time, often a year and in some cases several years.

A characteristic of such general courses for adults is that the intensity of study is far less than that of vocationally-oriented courses. They normally comprise just a few weekly lessons. This is not only a consequence of the subjects taught in leisure-time education. A significant part of the explanation is to be found in the fact that subjects of this kind require reflection and the acquisition of a substantial body of knowledge. Such subject matter takes time to digest, often working alone or in groups and usually with the aid of homework and independent reading.

Changes in society and in production are also characterised by the fact that the individual products embody considerable amounts of knowledge, and that such knowledge changes rapidly. There is also a trend that knowledge in itself is becoming a product. Good examples are the important software industry markets, the sale of general news services (of which CNN is a good example) as well as the marketing of specific information services where knowledge is tailored to the needs of individual groups. The nature of the production process thus changes significantly in an information society.

Such conditions transform the need for continuing education and training, the subject matter and the way in which it is organised.

1. 3. 3. The government has set itself the objective of increasing the capacity of continuing education and training by 60,000 full-time places per annum in the medium term. Converted this figure into student-weeks (40 student-weeks per full year student), it cor-

responds to 2. 4 million student-weeks per year. As the workforce totals approximately. 2. 9 million persons, the objective implies a little less than a week's additional continuing education and training per employee per annum.

This increase will scarcely be enough, certainly not in enterprises selling products and services with a significant knowledge content. It is therefore likely that we will be able to observe *an education and training pattern in coming years in which work, education and training and leisure will be largely interwoven.*

1. 3. 4. In reality, this is not a fundamentally new pattern. It was identified in, amongst others, a study on continuing education and training patterns carried out by the National Institute for Social Research in 1991. Those employed in occupations with a significant knowledge content not only got the lion's share of continuing education and training but also completed a considerable part of their studies by combining study in working hours with study in their own time.

What is new is not the pattern but rather the need to spread it to other occupational groups who to date have mainly received continuing education and training in the form of narrow, short courses in new skills. The reason for this - that the ability to adapt and the increased knowledge content of a given job has spread down through the hierarchical organigram - should be self-evident. The widespread debate about the need to give skilled and unskilled workers general qualifications in continuing education and training is primarily an expression of these changes in the production process.

To an ever increasing extent, we will no doubt be able to observe an education and training pattern in which actual course days are spread over a longer period of time. In the intervening periods between course days, those engaged in education will work with the course subject-matter on their own or with groups of colleagues either at home or at work. *Education and training will in other words be "spread thinly" over a longer period of time, and will take place to an increasing extent in many different places: at educational institutions, at home and at work.*

1. 3. 5. This transformation is not only happening out of economic necessity. It is not because there is neither money nor a readiness to pay for travel and accommodation, for wage compensation and educational costs during long uninterrupted periods of education and training. No, it is to a much greater extent related to the very content of the course and the nature of knowledge required. It is beneficial to digest newly acquired knowledge over a period of time so that the former can continuously be related and applied to experience in one's work.

This possibility of spreading continuing education and training provisions over longer periods of time is of particular importance for small and medium-size enterprises which may have problems rescheduling staff in order to let them go on courses. But also for big companies the ability to organise their continuing education and training effort more flexibly will be an advantage.

New technology-supported learning systems are of course not the only option when it comes to organising lifelong learning. But they provide good opportunities to tailor the course to the needs of the participants, to deliver education to participants wherever they are, and to make lifelong learning available when participants have the time. They will thus to a great extent make it possible to promote significant elements of such a flexible lifelong learning pattern.

CHAPTER 2

The economics of the education system in the nineties

2. 1. Introduction

2. 1. 1. The terms of reference of the committee state that any increased emphasis on technology-supported learning in the education system should not lead to a net increase in the total costs of a given education and training provision (assessed over a realistic number of years). Total costs encompass not only direct costs related to teaching but also indirect costs derived from lost wages/ wage compensation/ lost production/ travel and accommodation expenses etc.

In other words, if a reorganisation results in the increased use of technology-supported learning systems, it is to be budget-neutral over a given period of time. Such a change may thus mean increased expenditure in the initial phase, but seen in the long term these additional costs should be offset by falling costs towards the end of the period.

Such budget neutrality requires many detailed considerations. The committee has therefore chosen to collect and collate documentation which focuses on economic analyses in a number of appendices so that only the main issues are dealt with in this chapter.

2. 1. 2. The main issues which will be treated here are the following:

- How much do we actually devote to direct educational costs in Denmark, and what is the cost distribution for the various education sectors?
- What is the cost structure of traditional provisions compared with that of technology-supported learn

ing, what is the distribution pattern over time, and what as such is included in the concept of costs?

- What are cost structure trends for traditional pro visions compared with those of technology-suppor ted learning for the next eight to ten years?

2. 2. Educational expenditure

2. 2. 1. In 1991, Denmark spent the equivalent of 7% of its GDP on education and training. This figure includes private expenditure on education. Public spending accounts for most of this expenditure. No less than 12% of public expenditure in 1988 was devoted to education and training. If one deducts transfer payments (i. e. pensions, social benefits and the like), *26. 5% of the public operational expenditure and investments went on education and training.*

Public expenditure in constant 1991 prices has been more or less stable for the past 10 years, and in 1991 amounted to 57. 7 billion DKK. In all probability, the smaller year groups in the next few years will lead to a lower level of resource consumption for traditional post-compulsory courses. On the other hand, increased efforts on behalf of groups of young people who need more practically-oriented education and training opportunities will require increased consumption.

The cost distribution by areas of education is shown in table 1.

Table 1. *Distribution of public expenditure for education and training 1982-1991 by levels of education. All figures are in billion DKK at constant 1991 prices.*

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
Primary and lower secondary education	27.9	27.0	27.0	27.3	27.2	28.0	27.6	27.2	26.2	25.7
Post-compulsory secondary education	11.2	11.5	11.5	11.1	11.3	12.1	12.4	13.0	12.9	13.0
Higher education	9.6	9.9	9.9	10.1	10.6	10.0	10.6	11.0	10.9	10.6
Adult education	4.6	5.0	5.0	5.3	5.5	6.1	6.2	6.8	6.6	6.8
Administration, Auxiliary services etc.	1.7	1.9	1.9	1.8	1.8	1.9	2.0	1.8	1.7	1.6
Total	55.0	55.3	55.3	55.6	56.4	58.1	58.8	59.8	58.3	57.7

It appears from the above table that expenditure on adult education is on the increase, but in 1991, however, it still only accounted for 11. 8% or 6. 8 billion DKK. One can assume that this figure will increase in step with the implementation of the government's plan to add a further 60,000 full-time study places in adult education. On the assumption that the places in question are traditionally organised education and training provisions, and that the average annual cost per full-time study place is 59,700 DKK, both of which are elements of the government's memorandum "A new course for better times" (May 1993), then the total additional annual expenditure for these 60,000 new study places will be 3. 6 billion DKK. As the distribution of study places is presumed to match interest, the total additional annual expenditure will be somewhere in the order of 2. 4 to 6. 4 billion DKK a year, depending on the modes of education and training chosen. This figure does not include likely initial expenditure for buildings and equipment. Neither does it include wage compensation to cover lost wage earnings. The latter would in itself amount to something of the order of 5 to 6 billion kroner per annum. However, it would only constitute net expenditure for the public sector in cases where the person undergoing training is replaced by someone who is already receiving unemployment or social benefits.

2. 3. The cost structure in traditional provisions and in technology-supported learning

2. 3. 1. Almost all education and training in Denmark takes the form of class-based, direct teaching. Education normally takes place in specially-equipped educational institutions the basic structure of which has remained more or less unchanged for centuries. The main ingredient is *timetabled lessons in the daytime, where a class is taught by a teacher in each individual lesson.* What actually takes place in the course of a given lesson is the result of consensus among the teacher and his students. There are only a few areas where it is the practice to have fixed, predetermined curricula which

establish the content of the individual lessons. Labour market training courses do, however, constitute such an exception.

It comes as no surprise to anybody that the main cost in this kind of educational provision is the *salary of the teacher.*

In table 2 below, the committee has calculated the share of total operational expenditure in 1990 for a number of school forms which is accounted for by teachers' salaries. Total expenditure was 57. 3 billion DKK, of which the operational expenditure was 54. 1 billion DKK, corresponding to 95% of the total. As the investments in individual sectors may fluctuate considerably from year to year, as they are dependent on concrete building needs etc. , the calculation of the share accounted for by salaries has therefore been based on operational expenditure.

Table 2. *The percentage share of public operational expenditure accounted for by salaries in different sectors of the education system in 1990.*

Educational sector	**Salaries as a percentage of expenditure**
Primary and lower secondary education	80.4
Post-compulsory, upper secondary education	78.9
Higher education	76.1
Adult education, and continuing education and training	69.5
Total	78.5

Source: Ministry of Education

Education is thus a highly labour-intensive sector. Together with the social and health sectors, it is without doubt among the most labour-intensive partsof the public sector with salaries accounting for an average of 72. 6% in 1990.

2. 3. 2. When it comes to technology-supported learning, the cost structure cannot be determined with the same precision. Experience to date is still too limited to do so. Moreover, the concept of technology-supported learning covers a great number of variations as regards the organisation of the course.

In addition, there are two fundamental issues which make it difficult to compare the cost structure of the traditional provision with that of technology-supported learning. The first is the distribution of costs over time. The second relates to the categories of costs which are being used in the comparison.

2. 3. 3. The first problem is attributable to the cash flow in traditional provisions and in technology-supported learning. In traditional provisions, costs have to be paid at the same time as the course is held. As mentioned earlier, teachers' salaries are the dominant cost, but also costs such as the maintenance of buildings have to be covered throughout the course. In technology-supported learning, the cost structure is far more varied, but as a general rule a substantial part of the costs fall due before the course has been held. This applies in particular to independent study systems, but also to computer conference systems (see section 4. 5.), which in pedagogical terms are most closely related to classroom teaching. That a sizeable proportion of course costs are payable so early is, in general terms, due to the fact that the course organisation and not least most of the course materials must be ready when the course starts.

Not only will the pattern of salary payments over time differ from that of traditional provisions. Technology-supported systems will also have a different cost structure. The share accounted for by teacher salaries will be lower. How much lower depends a great deal on the mode of technology-supported learning. On the other hand, there will be labour costs for other manpower categories including technicians, programmers, publishers etc.

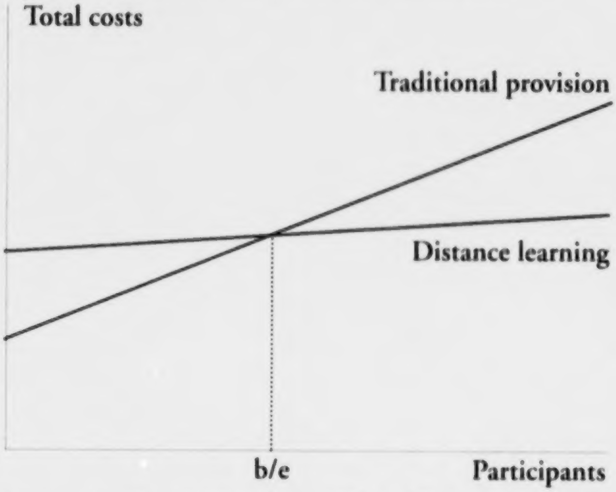
2. 3. 4. The cost structure in traditional provisions and in technology-supported learning also differs as regards the proportion of fixed costs and variable, student-dependent costs.

In a traditional provision, the biggest outlay covers ordinary classroom teaching, and costs will therefore be student or class-dependent to a considerable extent. In the new grant-awarding systems which are based on the taximeter principle, the grant unit is the student, regardless of whether costs for traditional provisions are largely related to classroom teaching or not. At a given school, it is the number of classes (and thus the student/teacher ratios) which is the decisive economic factor. There will therefore be some characteristic quantum leaps in costs each time a new class is established.

In technology-supported learning, there are great variations in student/class-dependent costs. But what characterises a number of technology-supported learning systems is that, on the one hand, a major share of the costs falls due before the start of the course (primarily costs incurred in connection with the development of teaching materials) and on the other hand the fact that fixed initial costs account for a significant proportion of the total budget. The cost of printing, say, an extra book or pressing an extra CD-ROM will be a few kroner per copy.

The implication is that there is a certain minimum number of students required to make it worth while to organise a technology-supported course, but in return it becomes cheap to admit students once this number has been reached. Technology-supported learning systems are thus in principle well-suited as "free admission systems". The principle is shown schematically in figure 1.

Figure 1. *Model of the cost structure for technology-supported learning and traditional educational provisions.*



Source: Article by Chris Curran in Costel Workshop 1993: "The Organisation, Technology and Economics of Education".

Note: *In figure 1, break-even is reached when the enrollment number is b/e. At this precise point the total costs of the two educational provisions are identical.*

The simultaneously-distributed learning model (see section 4. 6.) constitutes an important exception to the rule. This mode is a form of classroom teaching, the major difference being that the participants are located at several different sites. In this mode, operational costs are defrayed at the same time as the course is held.

2. 3. 5. The concept of initial costs is related to the second fundamental problem: what does the concept of cost actually comprise in traditional provisions as opposed to technology-based systems?

In the committee's opinion, when it comes to expanding the capacity of the education system, there is no fundamental difference between initial costs in relation to the building of institutions, the purchase of equipment and the development of textbook material for the traditional provision on the one hand, and initial costs in relation to the establishment/extension of telecommunication networks, and the purchase/development of materials for the technology-supported systems on the other.

There is a clear tendency to overlook such investments in analyses of the total costs of traditional provisions when unit costs are being compared. This omission may be justified in the traditional system, as cost structures are generally comparable within the individual sub-systems.

It does, however, give rise to a problem when traditional courses are to be compared with technology-supported learning, as there is a clear tendency to define infrastructure costs etc. as projected operational expenditure. Our study of the calculations made by institutions shows that, when putting forward economic models for distance learning, they both include all initial expenditures in relation to distance learning such as the depreciation of books, and at the same time charge distance learning with the same marginal return for building maintenance and use of technical-administrative staff as applies to ordinary students who are studying on a full-time basis.

2. 3. 6. The same applies to the financing of teaching materials - "textbooks". Here practice varies in different parts of the education system. In the Folkeskole (primary and lower secondary school) and in post-compulsory education, teaching materials have traditionally been free, although in recent years there has been an increasing tendency to introduce limited user charges. Here one may reasonably claim that the annual purchases of books by educational institutions lead to an annual depreciation of the publishers' costs. In the field of higher education and adult education (with the exception of the HF (higher preparatory examination course / upper secondary level) and general adult education courses), the practice is, however, that the students pay for all teaching materials themselves. In this case, the costs are thus invisible on the institution's operational budget.

Book purchases may well involve major outlays, figures of 4-6,000 DKK a year being far from uncommon in higher education.

In some technology-supported learning systems, teaching materials per se often form an integral part in a completely new way. For the time being it is thus reasonable to include electronic "textbooks", (e. g. assignments, dictionaries, grammatical exercises, interactive training modules) which are available to the students via computer networks, in the direct tuition fees. This also applies in areas where such expenses are normally not included in the budgets of the educational institutions.

In the medium to long term, one may assume that traditional textbooks will also change in character. They will either be published in electronic form only or in a combination of a traditional textbook and technology-based elements, for instance on a CD-ROM. There are indications that this development is already on its way to some extent in a number of subject-areas such as medicine and economics.

2. 4. Trends in the cost structure of traditional provisions

2. 4. 1. As mentioned in the introduction to this chapter, it was a condition for the committee's recommendations that they were to embody budget-neutrality over time.

Budget-neutrality can, in principle, be defined in two different ways. One definition is to assume that the cost trends in the traditional provision (with the educational standard we have today), and in technology-supported learning must be held at the same rate of increase.

With this method, it is possible to calculate how much dearer the traditional provision will be in the year 2000, if one assumes that unit costs per student per lesson remain unchanged. This will also give a measure of the freedom of scope for increasing technology support. If the rate of increase of technology-supported learning is just as high as in traditional provisions, there will be no "room" for investments in connection with this transition. If, on the contrary, technology-supported learning costs can be presumed to increase at a slower rate, or that they may even be maintained at their present level, then "savings" obtained in this way would constitute freedom of scope making it possible to finance investments in connection with the transition.

The second definition refers to the fact that the actual unit costs per student must not increase over time in any of the systems. In this case it is our task to calculate how large productivity gains the two systems must provide to keep actual unit costs at their current level as well as to assess whether such productivity gains are realistic, taking the subject and pedagogical aspects into consideration.

In appendix V, the committee on the one hand has gone through the expected productivity requirements for selected education sectors in the year 2000, and on the other hand it has calculated how much the unit costs per student would need to increase in order to maintain educational standards at their current level.

2. 4. 2. The Zeuthen committee expects an average annual productivity gain in urban occupations of approximately 2. 3% in the period 1992-2000. From

1981 to 1991, the gross domestic product at factor cost and at constant prices increased by 27% in Denmark, and the number of employed by 5%. The increase for each person in employment was approximately 21% over the ten-year period or approximately 2% per annum. The committee has therefore based its calculations on an average annual salary increase of 4% and an average annual price increase of 2% (in appendix IV for computational reasons, we have applied a 2% salary increase at constant prices).

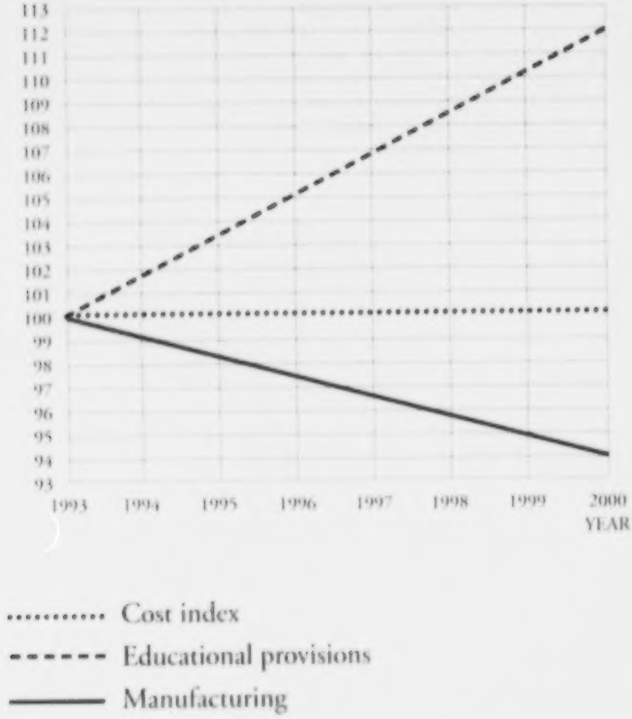
The prices of goods do not normally rise at the same rate as wages, because productivity increases as a consequence of technological advances and increased automation. Salaries account for a bigger share of costs in the education sector than is the case in the private sector. If the percentage salary increase in the education sector is the same as in the rest of the economy it will therefore lead to a greater increase in costs than would be the case for other goods and services.

To put it bluntly, this means one of two alternatives: either society must be willing to pay more (in constant prices) for education in the future to maintain present educational standards or, given

- that teacher salaries are to match increases in salaries in other parts of the labour market,
- that the quality of education provisions is to be maintained,
- and that, at the same time, the cost of provisions may not increase then it is a prerequisite that productivity gains in traditional provisions correspond ing to those underpinning increases in real wages in other sectors of the labour market can be attained.

Figure 2 illustrates this increasing cost trend in traditional provisions.

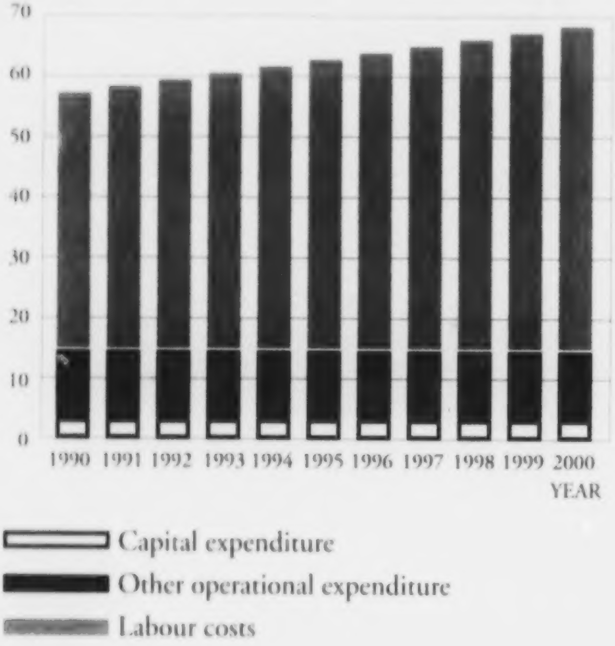
Figure 2. Cost trends for traditional provisions and for manufacturing 1993-2000 (1993=100).



The upper curve shows how the cost of educational provisions will increase if productivity does not increase, given that salaries increase by 2% per annum. The falling curve shows that the price of a commodity produced in an enterprise where wages only account for 40%, given a productivity gain of 4% a year (with unchanged profits), will fall correspondingly. The horizontal curve shows that the general price index is presumed to remain unchanged.

2. 4. 3. Figure 3 shows the calculated increase in expenditure for education and training from 1990-2000, given that educational output remains the same, that educational standards are not reduced, and that increases in teacher salaries follow those of other sectors of the labour market.

Figure 3. *Calculated increase in expenditure for education and training from 1990-2000, given that educational output and educational standards remain unchanged, and that increases in teacher salaries (% per annum) match the national average (Billion DKK at constant 1990 prices).*



With the prerequisites mentioned, the annual expenditure on traditional provisions at constant prices will have increased from less than 57. 3 billion DKK in 1990 to about 66 billion DKK in the year 2000. It remains to be seen whether society in the year 2000 will be willing to pay an additional 9 billion DKK a year in order to maintain present educational standards. On the basis of this forecast, the cumulative additional expenditure for the entire period 1990-2000 will amount to a total of 50 billion DKK.

It is not our task to predict political will in this respect. In hindsight, this willingness has not been there in the past. Demands that the educational sector should make productivity gains of the same order as the rest of society have been repeated in one financial policy report after the other. The soft option so far has been a reduction in the resources per student/ pupil. Whether the productivity gains (here defined as the yield per resource unit used) have been sufficient to prevent a reduction in the quality of educational provisions is by no means certain.

2. 4. 4. In the educational sector it should be self-evident that the words optimisation and productivity gain have hitherto been synonymous with cut-backs and quality reductions. The dilemma central to all Western economies is whether there should be a willingness to accept the natural buoyancy in public sector expenditure due to their special labour-intensive cost structure, or whether educational staff should balance gains in their real remuneration with productivity increases, as is the case with other groups in society.

Traditionally in the education sector there have been three "productivity control regulators" which could be turned up. They are:

1) Increases in the number of pupils/students in the classes.
2) Reductions in the number of lessons per pupil/student.
3) Changes in the regulations pertaining to teacher workload so that teachers are given more classroom hours per year.

All three productivity regulators have been used diligently in recent years.

In appendix V, the cost structure for a number of traditionally organised courses has been studied. In this context, calculations have been made for 1992 to determine the minimum number of pupils/students required to ensure that income covers the costs of the courses selected. Subsequently, corresponding calculations have also been made for the year 2000. Projections are based on unchanged receipts per pupil and on the fact that the course is organised in precisely the same way in year 2000 as in 1992.

For a technical school this will mean, for instance, that 129 students will need to be admitted in the year 2000 compared with 111 in 1992 (the example is based on an electricians' course). For a two-year higher commercial examination course, 508 students will need to be admitted in the year 2000, whereas in 1992 equilibrium was achieved with a student enrollment of 434. At a college of education, 391 students will need to be admitted in year 2000 compared with 335 in 1992. For further details concerning these calculations please refer to appendix V.

2. 4. 5. If the increase in real wages in the calculations is smaller than anticipated, the longer it will take before productivity requirements have to be met. If the increase is higher, the period will be shorter. One thing can, however, be anticipated with great certainty: the achievement of productivity requirements will lead to considerable debate. At post-compulsory level, there has been a drop in intake due to demographic factors. For vocational schools, this will no doubt mean that many schools will have difficulties in getting sufficient enrollments to ensure their survival, even though they have been able to show productivity gains in relation to the organisation of their courses. This development will thus accentuate the trend to shut down small institutions. Only large schools in urban areas will be able to survive. (It is, however, possible that the expected increased supply of continuing education and training courses will postpone this closure of institutions. The development will nevertheless mean that individual schools will be forced to reduce their range of courses).

For higher education courses which have achieved huge "productivity gains" in the 1980s, the debate about poor educational standards has been going on for several years. To date it has resulted in an agreement for the 1993-1996 period, so in this area the clock has been brought to a partial halt for some years.

A fundamental question is whether, in the coming decade, the education sector will be able to meet productivity requirements equivalent to those in the rest of society, given that the "production system" of the educational sector has remained largely unchanged since the nineteenth century.

The assessment of whether it will be worthwhile reorganising parts of the course to forms with increased technology support must therefore, from a purely economic consideration, build on an evaluation of whether investments in reorganisation along with the development rate of the operational expenditure for technology-supported learning, when aggregated, can be kept within the total forecast increase in expenditure for traditional provisions for the period 1993-2000, with an unchanged educational standard.

2. 5. Trends in the cost structure in technology-supported learning 1992 - 2000

2. 5. 1. It is much more difficult to make total projections of the expected trends for the economic development of technology-supported learning as it is organised in Denmark.

On the one hand this is due to the fact that, generally speaking, very little research or analysis is being done on the cost structure of technology-supported learning, and on the other hand that only in very few areas are such systems in regular operation in Denmark. The available empirical data comprises mainly small-scale experiments. This means that the major economic advantages of technology-supported learning, the fact that it becomes comparatively cheap to educate a considerable number of students, only show up to a limited extent in the examples which the committee has been able to study. Recurrent characteristics of all kinds of technology of potential interest for technology-supported learning include their considerable initial set-up costs and the subsequent drastic price reductions when products have been developed and marketed. The committee is therefore of the opinion that it would be possible to take samples of the general price development in the information technology area and on this basis draw up some trends having a bearing on the cost structure for technology-supported learning.

2. 5. 2. *Hardware* developments have been characterised by three very clear trends:
1. Rapidly falling prices
2. Rapid increases in computer performance
3. Shorter product market life.

As an example we have chosen figures for typical personal computers and modems. The Danish Technological Institute is the source of the prices of equipment and programs. Price trends in constant prices can be seen in the following tables and figures.

***Figure 4:** PC price trends 1986-1993*
(DKK, constant 1992 prices)

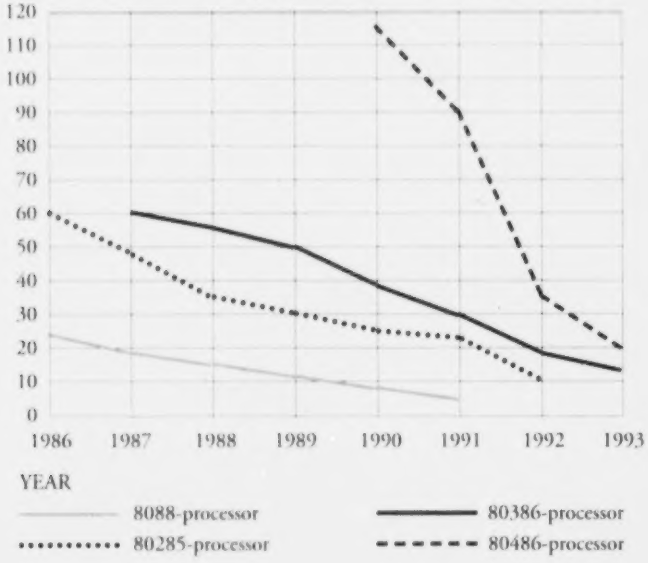


Table 3. PC price trends 1986-1993
(DKK, constant 1992 prices)

Year	8088	80286	80386	80486	Net price index
1986	23.399	59.113			81.2
1987	17.921	47.790	60.932		83.7
1988	13.652	36.405	54.608		87.9
1989	10.881	28.189	48.649		92.5
1990	7.338	25.157	37.736	115.304	95.4
1991	5.102	22.449	31.632	88.776	98.0
1992		8.000	17.000	35.000	100.0
1993			12.770	19.646	101.8 1)

1) Estimate

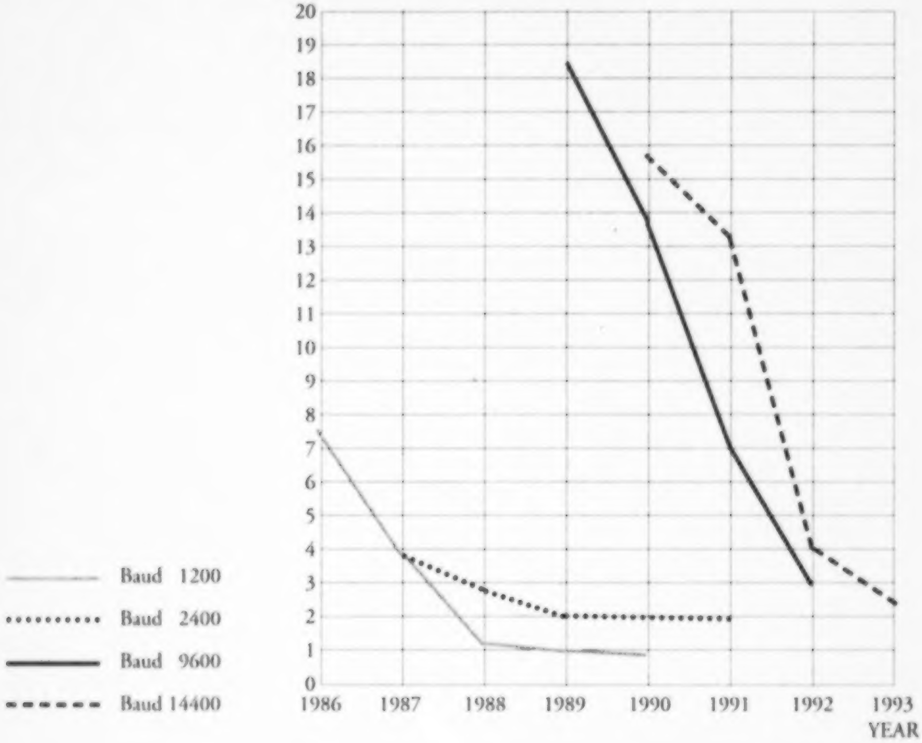
Source: Danish Technological Institute

Table 4: Modem price trends 1986-1993
(DKK, constant 1992 prices)

Modems baud	1200	2400	9600	14400
1986	7.389			
1987	3.823	3.823		
1988	1.251	2.617		
1989	865	2.054	18.378	
1990	734	1.992	13.627	15.723
1991		1.939	7.143	13.265
1992			3.000	4.000
1993				2.456

Source: Danish Technological Institute

Figure 5: Modem price trends 1986-1993 (DKK, constant 1992 prices)



Figures for the so-called multimedia, i. e. media which encompass pictures, sound and data, have followed a similar price trend. This can be seen in the following examples:

Table 5. Price trends for multimedia hardware1986-93 (DKK, in constant 1992 prices)

DKK	1985	1993
Videodisc player	49.751	9.823
Videocard/PC configuration	49.751	4.912
CD-ROM-discs, unit costs per disc	49.751	3
CD-ROM drive	18.657	2.456

The trend is to include multimedia facilities in all personal computers. At present, however, multimedia involves separate components connected to a personal computer, or stand alone systems.

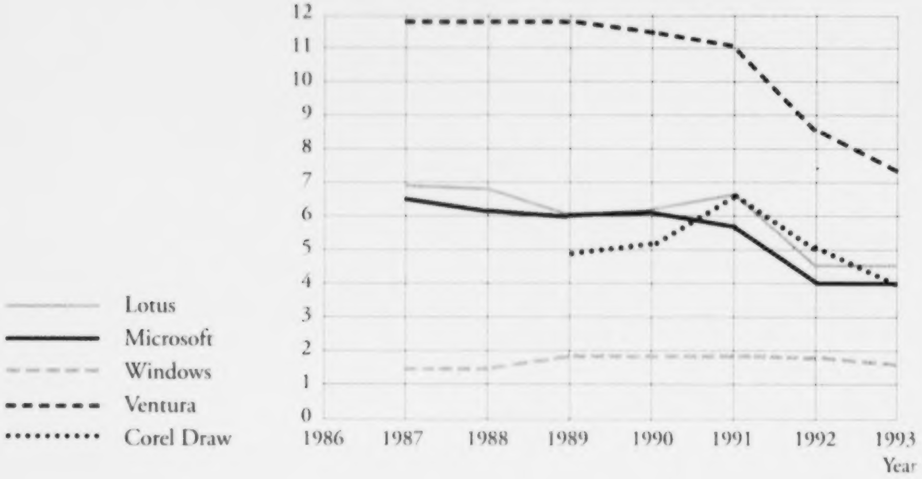
2. 5. 3. While hardware prices have shown dramatic cuts, the drop in the prices of software has not been quite as dramatic. Here one should distinguish between off-the-shelf software and specially developed software. It goes without saying that it has not been possible to make surveys of the price trends for specially developed software, but below we have drawn up a list of a number of off-the-shelf programs. As is the case with hardware, there is a continual development in the quality of programs so that the latest releases have many more functions than the older ones.

Table 6. *Price trends for selected software packages 1987-1993 (DKK, in constant 1992 prices)*

Year	Lotus 123	Microsoft	Windows	Ventura	Corel Draw	Net price index
1987	6.930	6.571	1.464	11.828		83.7
1988	6.810	6.143	1.394	11.832		87.9
1989	5.946	5.946	1.730	11.784	4.865	92.5
1990	6.184	6.080	1.834	11.426	5.241	95.4
1991	6.531	5.612	1.786	11.122	6.429	98.0
1992	4.500	4.000	1.600	8.500	5.000	100.0
1993	4.420	3.929	1.473	7.367	3.929	101.8

Source: Danish Technological Institute

Figure 6. *Price trends for selected software packages 1987-1993 (DKK, in constant 1992 prices)*



In short, it is thus possible to observe clear decreases in the prices of general purpose information technology systems. Furthermore, prices have clearly tended to fall more rapidly in recent years. While the annual percentage price decrease of a 286 PC was 28. 4%, a 486 PC dropped in price by 44. 5% a year. The same goes for modems. For software, the annual price decrease is in the order of 5-8%.

An additional characteristic of the market in recent years is the lack of transparency in hardware and software prices due to the bundling of hardware with installed software. If one compares list prices for hardware and software with the prices for the same components when bundled it often seems to be the case that low-performance systems (for example, a PC based on a 386 processor at present) are being sold as a free bonus on top of the software package!

It is not possible to make similar surveys of the price trends for professional authoring tools for the development of specific educational programs. In Denmark, many use systems which they have developed themselves. For a typical commercial authoring package like Tencore, while the retail price has been stable (approximately 47,000 DKK) the package has improved considerably and is now easier to use, which in turn can be assumed to have reduced the production costs of educational programs. Authoring tools are, however, still "niche" products which have not yet been subject to the same competition as off-the-shelf products.

2. 5. 4. If technology-supported learning systems are to function in real life they will normally require network connections for the interchange of sound, images and data. Here the situation is confused; the options and services are innumerable, e. g. local area networks (LAN) or connection to public networks; prices may fluctuate drastically dependent on the kind of data compression used. The latter is decisive because it affects the duration of the connection and thus the charges for using the network.

At the same time, it is in this area of new information technology systems that established monopolies are still alive, unaffected by global competition which makes itself felt in the rest of the information market. Such monopolies are particularly glaring in Europe, and this is an issue of which the European Commission is very much aware.

Comparative studies of network services including the USA and Australia are difficult, as the charge structures are so different. If one, for instance, compares rates for ISDN-2 (2 64 Kbit/sec. channels - i. e. 2 telephone lines) in 1993, the price of an hour-long call is as follows:

Table 7. Hourly ISDN-2 telephone rates for selected regions/countries in 1993

Country	Hourly rates
USA	180 DKK
Australia	300 DKK
Europe (Copenhagen - Rome)	540 DKK
Great Britain	72 DKK
Denmark	84 DKK

These figures are all national/continental rates, and there is thus a great difference in the distances. Telephone rates should logically be a function of the transport distance on the cable network. Measured as cost per kilometer, the rates are, however, much lower in the USA and in Australia. It is thus much more expensive to make a telephone call between Copenhagen and Rome than between Los Angeles and New York although the distance is much shorter.

Satellite time (hourly rent of a transponder) costs 12,500 DKK in Europe in 1993, whereas the estimated hourly rent in the USA is of the order of 300-500 DKK an hour. (This is a computed hourly rate, as one is normally expected to rent a minimum of 400 hours per year. If this number of hours is not used in full, the rate per used hour increases correspondingly). The huge price differences between the USA and Europe are however also the result of the compression techniques used in the USA which makes it possible to "pack" more signals into each channel.

Such price differences are, of course, not tenable in the long run, and it is therefore likely that within the next few years monopolies will also be dismantled in this area in Europe, resulting in rapidly falling prices. Both in the USA, Canada and Japan, there are current plans for massive extensions to high-capacity information networks (the so-called electronic superhighways). The European Commission is also working intensely on an extension of electronic networks with a view to linking up the countries of the European Union.

2. 6. Summary

2. 6. 1. In the committee's opinion, it must be assumed that the total demand for education and training is on the increase. Young people not currently enrolled in vocational education and training should be given an offer of education and training in the future so that they will also be able to find themselves a place in the labour market. At the same time, the requirement for updating and upgrading already acquired qualifications is on the increase, and there will also be a growing need for continuing education and training which will account for an ever-greater proportion of the total activities of educational institutions. All in all, the education sector will therefore become more expensive.

At the same time, there will no doubt be a buoyancy in the cost of traditional provisions, because they are so labour-intensive, and because the teachers' salaries are likely to follow salary trends for the rest of the labour market in the long term.

2. 6. 2. Danish experience with technology-supported learning systems is still so limited that, on an empirical basis, it is not possible to say anything for certain about the development of the cost structure of courses organised with technology support. When it comes to a number of important elements concerning hardware, software and networks which form part of this learning mode, significant price decreases have been observed in the period from 1985 to 1993. Although price decreases are greatest on the hardware side, similar if small trends have been observed as regards software. It must be assumed that this price trend will continue.

The price decreases are greatest for components for which there is free global competition, whereas in areas with de facto monopolies, including telecommunication services, prices are still high. They can, however, be expected to fall in the next few years.

If technology-supported learning modes are to become economically advantageous, given time, it will be crucial that standard learning programs are developed for a sizeable market so that the product unit costs will fall significantly, or alternatively that it will be necessary to continue to rely on a fragmented market with relatively expensive applications tailored for educational purposes. Another important factor will be the extent to which it is possible to organise the course so that economies of scale can be obtained.

The need for developing tailor-made applications must therefore be evaluated carefully and weighed against the costs incurred in this context. Wherever possible. standard programs should be chosen, and investment in isolated program development for the Danish market should be avoided. Such a model would probably only be economically viable where the issue is one of "mass education" and/or significant productivity gains.

2. 6. 3. In subsequent chapters, the committee will deal with questions relating to educational pedagogy, the choice of technology and organisational structure in more detail. But the committee would like to emphasise in this chapter that it finds that the increasing focus on lifelong learning will change the composition of education and training provisions at individual educational institutions so that an increasing part of their activities will consist of organising educational courses for adults who will be returning on a recurrent basis throughout their lives. The terms of reference presume that new and independent institutions should not be established for lifelong learning. The committee endorses this.

In cooperation with a number of other parties, educational institutions should be prepared to assume responsibility for an increased supply of flexible adult education and training based on technology support. Young people Tere also have ample opportunities to enroll in traditional full-time courses of education. It is also possible to introduce technology-supported study options here as modules in such courses where there is an economic incentive to do so. It may, for instance, be in the form of distributed learning for small subjects. It may be in disciplines with obvious economies of scale, including an increased use of educational programs based on pupils studying independently (alone or in groups) or with limited teacher support.

The committee has already underlined that the not insignificant need to expand teaching capacity in adult education. The committee has also underlined that sizeable sums of money are already spent on such courses today. If technology support were to facilitate the reorganisation of a mere 1/5 of the traditional provision so that it became 10% more efficient by increasing, say, the class sizes or by reducing course time without reducing its quality, this would in itself make it possible to increase the capacity of adult education by 15,000 full-time places corresponding to an annual expenditure of 900 million kroner.

CHAPTER 3

Technology-supported learning in the nineties - for whom and how?

3. 1. Technology-supported learning (distance education) - what is it?

3. 1. 1. The terms of reference of the committee mention"teknologistøttede undervisningssystemer"(technology-supported learning systems), "fjernundervisning" (distance education), and "fleksibel uddannelse (flexible learning). In English, one often hears the terms distance education, open learning, open flexible learning, and open distance learning.

For experts in the field, the various terms contain clear nuances, and they reflect that there is a panoply of different modes of organisation.

The concepts of "*uddannelse*" (education) and "*undervisning*" (instruction, teaching, study, learning) are often thought of as synonyms and are used indiscriminately. But here, too, there are differences.

Education is generally used as a designation for a complete, subject-related course leading to a qualification: the vocational course leading to a journeyman's certificate as a baker, or a university degree in law are courses of education. But the concept of education is also used to describe the organisation of that course. The course of education leading to a journeyman's certificate as a baker is, for instance, organised like a sandwich, so that parts of the course which take place at a school alternate with periods of practical training in an enterprise.

Instruction/teaching is normally defined more narrowly as the circumstances in which learning takes place. It is thus used in such compound words as classroom or group instruction. Classroom instruction has so far been conceived as all kinds of study in which the students and the teacher (normally only one teacher) are present in the same room. Group instruction may be organised so that the groups work in the same room as the teacher, but they may also be located in several rooms, and they often study on their own without the presence of a teacher, or the teacher goes from one group to the next.

3. 1. 2. The reason for there being mention of flexible learning, technology-supported learning and distance education in the terms of reference is that the education/instruction framework comprises both the organisational aspects of a given course (flexible learning) and the means by which learning takes place (distance learning/technology-supported learning).

In the report, we are thus not concerned with the subject matter of a given course, but solely with how this subject matter can be organised from start to finish and/or the circumstances in which learning takes place.

The classical definition of distance education is that it is

All forms of study where the teacher and the student are not present on the same premises.

It should be evident in subsequent chapters that the committee also finds that certain forms of study where the teacher and students are still present in the same room should be covered by the definition, i. e. situations where the students are largely studying independently with technology-based course materials and where the role of the teacher therefore changes from that of being in control of the instruction to one in which he, to a considerable extent, acts as a consultant to the students as and when they feel the need for his assistance.

The definition of distance education/technology-supported learning which will thus be used in this report is therefore the following:

Distance learning and technology-supported learning are all forms of study where the teacher and students are not present on the same premises, and where study is systematically and deliberately supported by technology. The concept furthermore includes forms of study which are supported by technology, leading to changes in the role of the teacher from that of having control over the learning situation to one in which it is the student who assumes responsibility for his studies and the teacher therefore acts as a consultant, as and when the student feels the need for it.

3. 1. 3. Technology-supported learning is thus a matter of study and its relation to the concepts of time and/or space, but also of greatly changed teacher/student roles. In our report, the committee has also emphasised that it must be a matter of the pedagogical organisation of a given course and that such courses to a certain extent should be supported by a dialogue between the teacher and students and/or among the students themselves.

These new forms of study can also be viewed as extensions of the classroom allowing it to cover greater distances and/or a longer period of time.

Instruction in the extended classroom may thus:

- take place at the same time, but in different places
- take place in the same place, but at different points in time
- take place in different places at different points in time.

Implicit in the last part of the definition is that it may, however, also

- take place at the same time and in the same place but in various ways in accordance with individual needs.

3. 2. Concerning the rest of this chapter

3. 2. 1. The following sections deal with technologies which are used in the course delivery modes mentioned above. They cover both the requirements which are made of the organisational aspects of educational provisions and the requirements for cooperation.

There is also discussion of the target groups which can be expected to benefit in particular from the use of technology-supported learning, either when adopted as the mainstay of a given course or as a technology-supported learning module within a traditional classroom-based course. The final sections deal with the pedagogical requirements which are specific to these educational/study delivery modes.

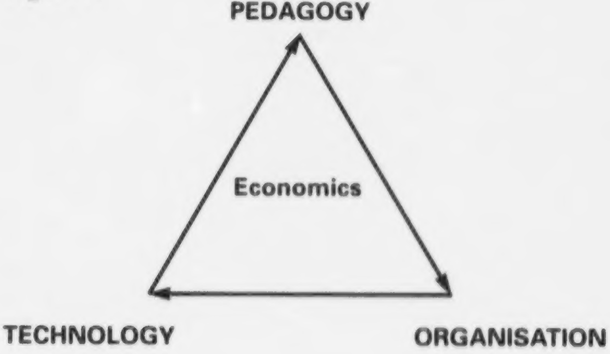
3. 2. 2. In written works of this kind, the issues of technology, organisation, pedagogy and target groups would normally be found in different chapters written by experts from each of these fields. The fact that they have been deliberately brought together in one chapter reflects the need to emphasise that the choice of technology, of organisation and of pedagogy are inextricably linked together. Ultimately, many of the choices also depend entirely on having the economic means to implement them.

If, for instance, one chooses a model like the British Open University in the form which it has taken so far, then a choice of technology consisting of television and radio broadcasts combined with pre-produced study material has been made. At the same time, one has implicitly chosen an organisational model which builds on a specific central body which mass produces materials held in storage until required. The pedagogical implication is that the target group consists mainly of students who aim to acquire a second degree and who require the opportunity of pursuing and completing their studies at their own pace, and therefore need to be able to start whenever they want to.

This again leads to the pedagogical/organisational decision that, in addition to radio/television broadcasts and textbooks, this study mode is also supported by local tutors who have not normally been involved in the planning and production of the study materials. And finally this model was conceived in an economic framework which dictates that the development of course materials in this way is so expensive that society can only afford to have one body responsible for it, given that huge student enrollments are required and that course materials must be used over a considerable number of years.

Graphically, the relationships can be described as follows:

Figure 7.



3. 2. 3. The appendices to this report contain comprehensive surveys of the technological options (appendix VII) and of the pedagogical issues (appendix VIII). In this chapter, the committee will only outline the key issues with the aim of explaining the connection between technology, organisation, cooperation and pedagogy. In chapter 4 which follows this one, we will

describe the three scenarios which we submit as our proposals. They take as their point of departure Danish traditions regarding pedagogy and organisation and they keep within the basic desideratum of the terms of reference that such proposals be economically viable when viewed over a number of years.

3. 3. On learning supported by technology

3. 3. 1. Technology is no novelty in education. Its importance can be simply put in terms of three quantum leaps in the history of education:

1: the invention of the written language
2: the invention of printing
3: the development of the information technology.

The significance of writing for the organisation of instruction was that dialogue was no longer a synchronous affair and could now be conducted at a distance (as long as there were horsemen or, later on, a postal service which could convey the written communication).

Printing made it possible to mass produce books so that they became available to many more levels of society. The first large-scale "information technologies", radio and television, further extended the opportunities of mass education.

The latest information and communication technologies - computers, CD-technologies and not least electronic networks - on the one hand have made it possible to tailor instruction so that it can be adapted to the needs and prerequisites of the individual, and on the other hand have provided an almost unimaginable potential to reintroduce dialogue and/or conversation between several people irrespective of time and distance. We can only hazard a guess as to the limits of this potential: that new technologies will allow for radically different instructional modes in the course of the next ten years now seems quite obvious.

3. 3. 2. As mentioned earlier, the use of technology to support study is no new invention.

Below is a list of the most commonly used technologies in educational provisions:

- books
- blackboard
- chalk
- photocopies
- printed correspondence course materials
- overhead transparencies
- radio
- television
- telephone
- telefax
- audio cassettes
- video cassettes
- linear computer-based instructional programs
- interactive computer-based instructional programs
- CD-ROM
- videodiscs
- multimedia CD-formats
- electronic mail
- computer conferencing systems
- bulletin boards
- video conferencing systems

As mentioned at the beginning of the chapter, there are three features of technology-supported learning systems to which the committee has attached great importance. They are the potential for:

- transcending distances
- transcending time (i. e. providing time-independent learning)
- creating a dialogue between the teacher and the students and/or among the students themselves.

The technologies (also termed modes of delivery) in question have been described in more technical detail in appendix VII. Here the focus is on their qualities in relation to learning.

Most of these modes of delivery can transcend distances. But they have radically different qualities as regards their potential for providing time-independent learning and for facilitating two-way communication. Below, selected modes of delivery are listed in tabular form on the basis of their potential for time-independent learning and to facilitate two-way communication.

Figure 8. *Advantages and disadvantages of selected modes of delivery*

Time flexibility two-way communication	**Good**	**Bad**
Good	Communication via electronic media: - telefax - electronic mail Use of computers - computer conferencing - interactive media (CD-ROM), multimedia CD-formats	Speech: - telephone Interactive speech/images: - video-conferencing - exchange of digital pictures
Bad	Books Printed material Sound cassettes Video cassettes	Broadcast media: - radio - television - text TV one-way transmission of digital images

As can be seen from figure 8, in most areas there is a choice between mature and new technologies. The course suppliers' choice of delivery mode will often be made on the basis of the technologies already available or those which they expect the users already have, if the latter are expected to purchase equipment themselves. It will also be a question of the funding and the technological expertise available, this being applicable to institutions (suppliers) and users alike.

It is probably of particular importance to underline that *the so-called user interface, i. e. front end with which the user is confronted and with which he is expected to interact, must either be easy to use or must be known to the user in advance.* In other words, technology exists for the sake of the users and not vice versa. And mature technologies can be at least as appropriate as new ones! The decisive factor is the nature of the qualities that will be attained by incorporating elements of technology-supported learning in courses.

3. 3. 3. There are many more instructional technologies than those appearing in the figure. It is worthwhile noting that all were originally developed for purposes other than teaching. Although the education sector is comparatively large in terms of expenditure, and although it will continue to be so in the future, there is nothing in Denmark or abroad to demonstrate that it will be realistic to imagine a given technology whose economic viability is based exclusively on the education sector as its exclusive market.

We must thus take as our point of departure the fact that although the extensive use of a certain technology in education and training may very well be of some importance for the survival of a product in a very competitive market, its survival can hardly be based on this market alone. If this is the case, the education system may well see pedagogically speaking useful technologies come and go because other products, contingent on their applicability outside the education sector, will win the battle for mass markets.

3. 3. 4. When we mentioned above that users should be treated on their own terms, this does not only apply to the question of user interfaces. It is probably of even greater importance to assume that *users cannot normal-*

ly be expected to purchase specialised equipment exclusively for educational purposes. If one therefore presumes that the user is to pay for his own equipment, then courses must build on equipment which one may reasonably expect to be widely used by the target group.

This applies in particular to courses which take place predominantly in the home and in small businesses. But also in medium-sized businesses and institutions there will be narrow limits as to the range of equipment which can be expected to be provided. Major businesses with considerable in-house training and large educational institutions on the other hand will be able to purchase equipment specifically for educational purposes because their turnover will normally be so high that such investments will be economically viable.

If society wishes to promote forms of technology-supported learning which presuppose relatively advanced equipment, some form of funding policy will no doubt be necessary, for instance by establishing study centres and by allocating grants to small institutions for their acquisition of equipment.

3. 3. 5. Something which characterises many of the above-mentioned products is that *the same educational result can, in fact, be achieved with a number of different technical solutions.* An example is the battle between the VHS and BETAMAX video cassette formats. Recent examples are operating systems for computers, electronic network systems and the as yet unresolved battle surrounding CD-formats.

There are still unresolved issues to ensure that different technologies work together, and there are still compatibility problems so that a variety of software products will work on various platforms. Such compatibility issues are, however, being tackled all over the world in recognition of the fact that in global markets it is no longer advantageous to try to defend a small national niche or market segment. On the contrary, consumers have negative views about products that cannot be used without complications in a so-called open architecture consisting of many types of hardware and peripherals, and involving several programs. Although significant progress has been made there are still some problems and one may still find oneself in situations analogous to having to carry a personal telephone with you around the world in order to make a call!

3. 3. 6. The above could, of course, be used by those who are scared of new technologies as a good argument for leaving them well alone and for playing a waiting game; there may still be problems getting technologies to function together; there is a risk of making erroneous purchases; equipment may even become very cheap as time goes by. It is, however, a question of a lengthy learning curve which, among other things, requires an active effort on the part of teachers in the individual institutions before elements of technology support have been integrated naturally into educational provisions in areas where it will clearly provide better instruction than traditional methods. And it is a process which requires the involvement of a far broader circle of teachers than just the teacher responsible for the computer room!

A prerequisite for the above recommendation is still, however, that the institution is fully aware of what it hopes to achieve by transforming parts of its courses to a technology-supported system.

3. 4. On organisation and cooperation

3. 4. 1. There is a close correlation between the technologies which are used for technology-supported learning or the framework for the structure of entire courses, and the organisation of the institution in question. A number of economic regularities and considerations often underlie these choices.

The most obvious models so far for the organisation of technology-supported courses have been institutions dedicated to so-called distance education which have exclusively used this delivery mode and have awarded their own degrees. The best known example is no doubt the British Open University which on an annual basis is still responsible for awarding more than 12% of all academic degrees in Britain. There are a number of other institutions based on the same model in other countries. Seen in a global perspective, it is conspicuous, however, that such institutions are very few and far between. It is also characteristic that the establishment of this type of educational institution seems to have stopped.

There are two features which have characterised this kind of institution. Firstly, it has as its aim the provision of mass education, either in the form of entire second-chance degree courses for adults who did not have this opportunity when they were young, or typically in developing countries such as India and Thailand as a means of rapidly and massively expanding educational capacity for young people wishing to be admitted to higher education.

Secondly, it is also typical that such institutions have used media such as radio/television and special course-book systems based on independent study, i. e. textbook systems which in principle aim to enable the student to study completely on his own using as his basis the study material provided. Characteristic, big warehouse buildings where teaching material were packed and dispatched to the students, and studio buildings for the recording of radio or television broadcasts were among the first things one noticed when visiting this kind of institution.

In several countries, these institutions have had an uphill battle to be recognised on a par with traditional universities. There has been some scepticism as to whether the quality of their graduates was as high as those who had received their education in the traditional way. Conversely, open universities have claimed that their graduates had proven that they could work hard, and that they were very well thought-of in the private sector.

But resistance by the old universities to credit transfer between traditional courses and those organised as distance education still flourishes in many academic circles in Europe. By ensuring that examinations passed in open education provisions (and as distance learning) automatically give credit in an equivalent full-time course, one of the significant obstacles to a coherent, lifelong education system has been removed in Denmark.

Post-compulsory and intermediate courses of education have also been offered as part of the open university model, but historically distance education has been most common at university level.

Technically speaking, it is a centralistic, large-scale model which in expert circles is also termed "the Ford model". This means that the products of mass production going into storage. For the British Open University, the useful life of TV-programmes has normally been about 10 years. It has also typically taken three years to develop a new course before it could be offered. Courses were then printed and stored for sale on an ongoing basis. Economically speaking, it is a mode of delivery which requires major investments, but whose unit costs on the other hand fall rapidly in line with increasing enrollments.

Technological choices and the organisation of the institutions were in part historically conditioned by production methods which were available from the 1960s until the end of the 1980s and in part conditioned by the need for real mass education. Video technology for instance was not so advanced that programmes could be edited for use on television. Another area that was not fully developed either was desk-top technology, in which personal computer technology makes it possible to rapidly edit and print small runs at low cost. For the establishment of open universities at a later date, such choices were probably not so rational. It is, for instance, natural to assume that the example and success of the British Open University in a number of cases have probably meant that several countries chose a similar construction without making any further analyses of whether the model was also the most appropriate choice for them.

3. 4. 2. Developments which have taken place in recent years are often characterised as a move towards "*dual-mode*" *institutions*, i. e. institutions which offer traditional courses of instruction both on a full-time and a part-time basis, and which to an increasing extent organise part-time courses for adults with the aid of modern technology. The explanation of this development is partly due to the shift in emphasis in adult education from adults in search of entire second-chance courses towards adults who may be interested in longer courses but typically in the form of modules constituting part of lifelong learning. The other - technical - explanation is that new technologies have a different cost structure which still requires economies of scale in order to be economically viable, but in no way to the same extent as the Open University model. It is also said that these institutions can bring courses to market employing the "just-in-time" principle.

Economies of scale in the dual-mode model are typically obtained by getting a number of institutions in the same area to join forces in a development and operational venture. They then establish a common, central body with limited staff which coordinates development projects and the like, and which functions as a common resource centre. It is typical of this form of organisation that the board primarily comprises representatives from the participating institutions and that as regards the development of the content of the courses, development projects are also carried out by special development teams manned with staff from the participating institutions. (As opposed to this, the Open University, for instance, is a "real" university with a sizeable, permanently employed staff in charge of the development of course materials).

An example of such a cooperation organisation is the Open Learning Foundation in Britain, which is a cooperation and development organisation with a number of universities as members. Other forms of cooperation are, for instance, the NIHE in Ireland and STOHO in Belgium, where universities have joined forces and have created a common development organisation, and furthermore where the operation itself is divided in such a way that it is the joint organisation which also assumes a number of administrative tasks relating to courses such as advertising, enrollment, registration for examinations etc. , whereas the subject-related counselling of the students typically still takes place at local level on the campuses of the participating universities.

3. 4. 3. The typical underlying philosophy, and organisation of dual-mode education in two separate departments at institutions now seems to have been replaced by a new type of institution. This type of institution has yet to be given a name (some call them "multiversities", but in the EU the concept is being discussed at present under the term "Technology into Main-Stream Education"). The former, relatively sharp distinction between full-time courses organised as direct instruction and part-time courses organised as distance learning with some form of technology support disappears in this model.

This means that teaching materials which were primarily developed for the use of the students in distance learning are to an increasing extent also being using to support full-time courses. This applies to lectures on tape, interactive training programs etc. Conversely, institutions while developing course materials for use in distance learning have gradually realised that in a number of instances it is more appropriate to gather the students for traditional instruction where, for instance, it is possible to explain the underlying concept of a subject. The explanation is that this kind of deeper understanding is not easily achieved in an independent study programme irrespective of the quality of the course material. Such a course largely requires direct dialogue.

There thus seems to be an ongoing trend to make more realistic assessments of the strengths of technology-supported learning components and of the uncontested advantages of traditional direct instruction, and then to mix and optimise the components in relation to the pedagogical objectives set for the course in question.

The implication is also that there will be an increasing number of "lessons" in the traditional courses where the students study individually using technology-supported learning, and that there will be an increasing number of direct instruction seminars in distance learning courses. Both modes of delivery will probably be supported by an additional opportunity for dialogue enabling students, when they are not physically together, nonetheless to communicate and work jointly on assignments with the aid of computer networks.

As a result of new information technologies, classical "classroom teaching/direct instruction" is also undergoing changes. New video-conferencing technologies, enabling students at a number of sites spread over a considerable area to attend the same lesson as well as see and talk to each other and exchange data etc. , mean that it is now possible to actually work with so-called distributed classroom instruction. This mode of delivery can also be supplemented by subsequent dialogue/cooperation supported by communication via electronic networks.

3. 4. 4. It goes without saying that this transformation

is not just something that comes of its own volition in an institution. It will make new requirements as to how work is to be organised at the institution, and it will require considerable cooperation between institutions. How do institutions which cooperate on distributed learning organise actual timetable planning and how do they, for instance, distribute receipts and expenditure? Or how do they calculate the contribution of the individual institution in the development of a given course? Can they freely use such materials or should there be charges and the like which are related directly to actual use? How do they organise cooperation on the use of networks and who is to pay? These are just a few of the questions which crop up when the framework of cooperation between several institutions is to be established.

An increased use of technology-supported learning will also mean that organising courses internally will no doubt have to be discontinued. In the traditional system it is relevant to ask whether it is reasonable to continue the traditional division into classes in periods where students work independently with computer-based study materials or whether other forms of organisation would not be more appropriate.

In the case of an increased use of direct instruction in traditional distance education provisions, questions arise about matters such as travel distances and board and lodging for students during week-end seminars. It is not particularly easy to organise this in a country like ours where we do not have a tradition of campuses, and where daily rates for course accomodation are such that participants who are to pay for it themselves drop out. And how many teachers are actually trained to plan coherent courses of a couple of days' duration where the course participants meet "fighting fit" and expect to get their money's worth in the form of committed and varied instruction? All this at the same time as ensuring that the practicalities of a smoothly-running course.

It is thus not just a question of organising a short course for the teachers so that they understand new technologies. It is actually an issue of making the entire organisation understand that technology-supported learning is a question of an integrated process where pedagogical, organisational and technological solutions on the one hand are interrelated, and on the other hand in some areas differ from solutions which have been used in the past.

3. 5. On target-groups

3. 5. 1. In chapter 1, we described trends in the educational pattern which we believe can be expected in the years to come. The key word was lifelong learning, not exclusively conditioned by a current need for continuing training and retraining due to rapidly changing job functions. A just as important reason was the emphasis given to the quality of life and the possibility of active participation in all aspects of social life.

As previously mentioned, there are no signs whatsoever to the effect that initial education prior to entering working life can be shortened - quite the reverse. The total need for education in society must increase quite significantly. Some education experts, including Sir Robert Telford who has been the chairman of the IRDAC-group, even believe that the emphasis will have shifted from initial education to continuing education in the course of a few years. In his opinion, at tertiary level we currently spend approximately 80% on initial education and 20% on continuing education and training. He predicts that in ten years the emphasis will have shifted so that universities will spend 80% of their capacity on lifelong learning and 20% on initial education. The same trend will no doubt also apply to vocational training.

If his predictions come true, the consequence will be dramatic reorganisations in these institutions, which have been accustomed to an educational pattern based on the education of young people for a continuous period, apart from periods of practical training. They have been responsible for educating (and socializing) young people for long uninterrupted periods on a full-time basis, and in such cases institutions literally speaking had the opportunity to lead their own lives. It will be a great revolution for such institutions to have a majority of students coming in and out of their doors, often dedicated but also critical, and who to a far greater extent than young people expect that their courses also take into account knowledge and experience they have acquired throughout adult life. A demand which should, of course, have a reasonable chance of being met!

3. 5. 2. In the past, the biggest target groups at traditional open universities were adults who had not been given the chance of an academic education when they were young. Like young people, they were thus seeking long, uninterrupted courses of education. There do not seem to have been such needs in Denmark. This may be due to the fact that capacity in higher education has been quite high in spite of the numerus clausus (the total number of available study places per year has constantly been higher than a year group of school leavers with an upper secondary school leaving examination, an HF-examination or other post-compulsory courses of education qualifying for admission to higher education). Nonetheless, given that there has been a relatively strict regulation of admission to some subjects, the reason may well be that many applicants for full-time, higher education courses in Denmark have been adults over 25 years of age. In other countries, these groups have enrolled in open universities with specially organised part-time studies instead.

That the pattern has been different in Denmark from that in, say, Britain, can no doubt be attributed to the British tradition of university students really working full-time and completing their studies within the stipulated time. The Danish tradition to date has been such that when first admitted, the student could stay enrolled in the institution for as long as he wanted. At the same time, it has been possible for students to study at a pace which enabled them to combine part-time studies with a job; the latter has been quite a common occurrence. In the humanities and social sciences in particular, where many older students are admitted and where, at the same time, many applicants are turned down, this has been the prevailing tradition. The pattern fluctuates a great deal from subject to subject. For higher education courses as a whole, 25. 6% of those admitted in 1992 were 25 years old or more.

3. 5. 3. Changes in regulations governing student grants and the recently-introduced tests at the end of the first year for students admitted to course stipulated as being full-time study will presumably reduce the number of part-time students taking up full-time study places in the future. But this will probably not mean that the pattern of continuing education will change so radically that a significant proportion of prospective students for continuing education will leave the labour market and go for long uninterrupted full-time Master's degree-programmes in the future. The majority will no doubt still enroll for modules lasting from 6 months to a year. This is also the pattern which can increasingly be observed in countries which have open university systems offering second-chance education.

3. 5. 4. An increasing proportion of adults seeking education in a lifelong course in Denmark will have a family. In some cases they will maintain an on-going connection to the labour market - and this applies equally to men and women. In other cases, by means of education amongst other things, they will attempt to maintain contacts with the labour market after they have become unemployed or perhaps never have gained a foothold there. Many of them will have limited mobility due to work and family commitments. As time passes, the majority will have a solid educational background as the foundation for lifelong education.

Many will be able to study during working hours, but some will also spend part of their spare time on home work and on independent study of the subject. Some will want to be able to complete most of the course at home. Others will prefer to study with a group of colleagues at work or in connection with their trade union. Some will prefer to follow courses during the daytime or in the evening at an educational institution as they are used to doing, and preferably in the neighbourhood to reduce travelling to a minimum. Others will want to study at their own pace and have the opportunity of repeating exercises with which they have had difficulties.

In short, it will be a question of a sizeable and varied group with very different needs. It will need to study in many various ways and in many different institutions, too. Technology-supported learning systems will be able to meet a number of these needs but by no means all of them. And there will be a variety of technology-supported learning systems, each with its own advantages and disadvantages in relation to special learning contexts. In chapter 4, we have listed a number of typical learning situations and described various technology mixes which, in combination with traditional provisions, seem well-suited for the learning situations in question. The approach adopted has had the aim of matching technology support with the prerequisites of the user and of increasing the potential for a rich and varied educational opportunity.

We refer the reader to appendix VIII which describes pedagogical problems specific to technology-supported learning systems.

3. 5. 5. In section 3. 4. 3. the committee described the increasing trend to use technology-based study materials originally developed for adult education as modules in traditional full-time education provisions. This may either take the form of supplementary materials giving the student the option of individual training or it may

be a question of a more radical reorganisation of the course where part of the traditional classroom instruction is replaced by technology-based delivery modes where these have proved to be more appropriate. The committee believes that what we have here is a permanent change which is also slowly making itself felt in this country.

The implication is that the target group for technology-supported learning is being increased, but probably in such a way that this mode of delivery in traditional, full-time education will only be used in parts of the whole provision.

The committee would like to point out that for certain young people and adults who do not have access to a full-time course for family or geographical reasons, a technology-supported course organised as "genuine" distance education will often be the only possibility. As most of these systems offer excellent means of administering and monitoring the student's activities, there should be no technical obstacles to offering such courses as full-time study programmes with the usual options of state educational grants and the like.

The committee has, however, found that this problem falls outside its terms of reference and has not dealt with the matter in more detail, with the exception of some remarks in chapter 4 about scenarios which would be best-suited for full-time courses offered as "genuine" distance education.

3. 6. And on pedagogy

3. 6. 1. For those concerned with the organisation of courses in countries other than Denmark, it is striking to see the impact that Grundtvig has actually had on Danish perceptions of good teaching and learning. Denmark has a tradition and an ideology of togetherness and solidarity. There is a bond between a teacher and his group of students who move both intellectually and physically within a room and engage in dialogue, with

little or no interference from others, until the examination approaches and in which, in reality, both the teacher and his students are evaluated. It is worth noting that Grundtvig did, in fact, turn against the examination-oriented, authoritative "black" school, and that examinations in the Grundtvigian tradition are considered as something extraneous, an imposition thrust upon the ideal educational situation by the outside world.

The actual amount of conversation and dialogue that takes place when a class approaches 35 students, or in lectures with several hundreds of students is debatable, but nevertheless the ideal remains! There are, of course, a number of other modes of delivery which are on the increase at the expense of traditional instruction, for instance team teaching and projects covering several periods. As an overall basic model, classroom instruction is however presumably still the dominant mode.

3. 6. 2. Similar myths exist about technology-supported learning, but they are by no means so positive. It is often criticised for being mechanical, for being of use only for very elementary skills, or for being a mindless and mechanical vehicle for mass education with no room for individual considerations. It isolates and alienates. It hampers dialogue and human togetherness. And it requires that the teacher has at least half an engineering degree to be able to teach with the aid of technology!

There are many myths which need to be torn down. Such prejudices affect both teachers and students, in particular mature course participants for whom technology was not a part of their upbringing. Technology is still considered by many as something threatening, and for this reason it should be kept at bay and subjected to criticism.

For young people, technology is something just as natural as the hamburger and coke which they consume in the nearest fast food bar. It is an aid and a tool they use for entertainment and for a number of other purposes. Psychologists talk about "decoding", a mechanism affecting the middle-aged and the elderly when they come across a new kind of technology. Decoding requires the learner to relearn things he is good at from scratch, requiring learning in a new way with new tools. Many people are reluctant to do this. For young people learning something for the first time it is quite natural to learn things in a new way. Young people simply do not understand the behaviour patterns of their elders.

It is, however, very characteristic that many mature course participants who have tried studying with the help of new technologies have been very pleased with such systems, having overcome their initial reservations. The prerequisite is, of course, that the so-called user interface is well-known or easy to use. Peripherals such as bar codes and light pens have proven to be a good starting point. Course participants have experienced the joy of being able to work at their own pace, and they have certainly had to modify their views as to the "dangers" of technology. One could also say that they have acquired a general technological competence which can be applied in many job situations.

3. 6. 3. Many teachers are in almost the same situation as their mature course participants. Both in their education and training as teachers and later on in instructional contexts they have concerned themselves almost exclusively with direct teaching based on the Grundtvigian ideal.

If such teachers are to take part in courses based on technology support, there will thus be a need for not just a change of attitude but also a number of new qualifications. It is, for instance, a question of the specific pedagogical approaches on which the various new systems are based, of a basic understanding of the functioning of the technology selected, of special requirements regarding the expected student "behaviour" in the case of video-conferencing for instance, of the supervision of a live teaching situation via, say, two-way video where the teacher must be in contact with and activate students at various sites around the country etc. Efficient teaching by means of, say, conference systems via electronic networks demands a special pedagogical skill: the teacher's role is not to answer questions from individual students but largely to stimulate twinning (a modern variety of peer-learning from the 19th century).

More than anything else it is important that the teacher faces up to the fact that his teaching will become highly visible and will be constantly subjected to evaluation by students and colleagues alike. In technology-supported learning, the teacher's efforts, theoretically speaking, are often stored "for ever" in the form of course materials and mail distributed by means of a conference system, in the form of video-taped lessons etc. The feeling that classes which were formerly private and closed are now being laid bare for the public to see can scarcely be avoided.

The teacher will also have to cooperate with experts from a number of other areas, e. g. technicians and administrators, to a greater extent than hitherto. They may come from his own institution, but many of them, more likely than not, will come from the outside in a widely branched cooperative network. That such cooperation is thus moving out of the teaching staff room and into a collaborative network will also, no doubt, be new to many.

3. 6. 4. In the opinion of the committee, it will be of decisive importance that teachers be given all round in-service training to provide them with the necessary knowledge and skills to use new information technologies in their teaching. In parallel with this initiative, as has already been mentioned, it is important that administrators and others at institutions who are to take part in the planning and implementation of new edu-

cational provisions *be given training within the same program* so an understanding of the connection between the technological, pedagogical and organisational issues has a broad institutional basis. The committee submits its detailed proposals for follow-up measures in chapter 5, see below.

The existing teacher training programmes and pedagogical courses should also be adapted as quickly as possible, so that new graduate teachers will be able to work with such technology-supported learning systems from their first day at work.

As the importance of education as an area of employment will no doubt increase, it would also be appropriate to include educational modules concerning specific planning, organisational and implementation issues of technology-supported learning as an option for professional specialisation in courses of public administration, from which the administrative staff of the educational institutions are generally recruited.

CHAPTER 4

Scenarios for technology-supported learning towards the year 2000

4. 1. Scenarios and models

4. 1. 1. In accordance with its terms of reference, the committee is to put forward a maximum of five scenarios which together meet the objectives of flexible organisation as regards time, distance, access as well as being a rational mode of delivering education. For each of the models, an investment plan and a plan of operations are to be drawn up showing the economics of that model with varying inputs. Furthermore, the pedagogical advantages and disadvantages of each individual model is to be described along with the requirements made by that model for changes in teacher qualifications compared with the requirements made of teacher qualifications in traditional classroom provisions.

The terms of reference underline that the models should, in particular, be appropriate for the teaching of adults and should not entail the establishment of new educational institutions. For each of the scenarios, the needs as regards cooperation and coordination to assure the optimal use of resources should be described.

4. 1. 2. Technology-supported learning may be an overall organisational model for the structuring of entire courses of education, varying in duration from a few months to a few years. Technology-supported learning may, however, also take the form of modules in traditional provisions. A general upper secondary education course, a vocational training course or a hig-

her education course could, for instance, contain modules based on technology-supported learning, where this has pedagogical benefits and/or is more feasible in economic terms.

There is currently a general debate abroad about "technology into mainstream education". This term covers a reconciliation between distance education proper and traditional direct teaching so that, generally speaking, both modes of delivery are found in the same institutions, and so both kinds become mixes of distance learning and direct teaching. The committee also believes that this pattern will characterise Danish developments, and it is in this light that the scenarios have been prepared.

In the scenarios, in accordance with its terms of reference, the committee will concentrate on the construction of models which build on technology-supported learning as the organisational backbone for entire courses. In the descriptions we have also, however, indicated the areas in which elements of such models would be appropriate, given a partial reorganisation of traditional provisions from the Folkeskole to, and including, higher education.

4. 1. 3. There are two basic approaches on which such scenarios can be based.
1: Using *technology* as the point of departure.
2: Using *learning contexts* as the point of departure.

There are many examples of descriptions which take technology as their point of departure. On the basis of a given technology mix (frequently decided by looking at what has already been acquired at the institution), an account is then made of what this technology is suited (or perhaps less suited) for. This approach is typically chosen by those who are enthusiastic about technology. The technology-borne description also has a tendency to concentrate predominantly on technological issues, and such descriptions easily assume the stamp of a "brave new world", where old and well-tried technologies are shoved aside.

The committee has chosen a second method, i. e. to use typical learning situations as its point of departure, and on this basis describe the likely technical platforms which would be natural to build on during the period in question.

Both technology and pedagogy change as time goes by, one affecting the other. We thus move from models to scenarios, as a scenario is - according to the committee's definition - a model which develops with time. The scenarios may thus include a number of typical technological platforms for the various learning contexts. Cooperation mechanisms and the organisation of education will also change in tandem with changes in technology and pedagogy. We will no doubt see a development in which technological changes will generally take place rapidly, followed hopefully by pedagogy, exerting in turn an influence on the technology chosen. Finally, and possibly more intermittently, the organisational structure will adapt to the changed technological and pedagogical scenario.

4. 1. 4. It is rarely a question of clearly distinct technologies, and at the same time there will be technologies of different "levels" of sophistication in society which are in use side by side. One can also foresee that some kinds of advanced technology which are currently feasible in, say, large companies and educational institutions as well as in advanced research institutions in the long term will become cheaper and more readily accessible for use, say, in the home, in small businesses and at small institutions.

One of the difficulties of describing a scenario for a ten-year period is to guess how fast advanced technologies will spread throughout society. Naturally the most interesting feature is to foresee which technologies will be common in the consumer market, and when this will happen.

When describing the scenarios, it is necessary to divide them somewhat schematically into boxes. But reality will be a varied patchwork. It will be possible to combine elements of the technology-supported learning systems as described here in the scenarios in a great number of ways. For this reason, such scenarios are not mutually exclusive. On the contrary, when viewed jointly they comprise a framework for technology-supported learning which, in the committee's opinion, will be able to cater for sizeable areas of the Danish education system for the rest of the decade.

4. 2. Distinctive Danish pedagogical characteristics

4. 2. 1. The committee has discussed whether it should use Danish or foreign models as its point of departure when constructing scenarios. Although empirical material for Denmark is by no means substantial, we have nonetheless chosen to use Danish examples. The justification for this are a number of characteristics peculiar to the Danish pedagogical tradition which the committee values as its foundation. But to a certain extent it is also due to the limited size of the country. Models which build on economies of scale starting from 2-5,000 students do not readily lend themselves to being adapted to meet Danish conditions.

When comparing flexible technology-supported learning systems *the main pedagogical difference* between the Anglo-Saxon world and Denmark which has been identified is the clear desire in Denmark to combine flexibility in time and place with a sense of belonging to a group stemming from a shared subject-related frame of reference. Grundtvig did not live in vain as far as technology-supported learning is concerned, either!

4. 2. 2. This sense of belonging is not the case abroad - quite the contrary it is safe to say. Elsewhere the freedom of the individual to start a course in any subject on demand and study at exactly the pace that suits him

are emphasised as major advantages. The lion's share of study materials in, say, English, German and Dutch educational programmes normally assume that the student, in principle, works alone with the subject-matter but with regular opportunities for teacher contact - usually someone who was neither involved in the development of course materials nor was responsible for the organisation of the course.

4. 2. 3. In order to counteract the feeling of isolation, students in the British model can go to a study centre where they can get advice and counselling in the company of others. But unlike Danish models, students do not have a common bond and a shared frame of reference relating to the subjects of the course. The only thing they have in common is that they are enrolled in the same programme.

When the committee in the following makes reference to a study centre model as a component of the scenarios (in particular scenario 2), then it should be noted that the centres in mind have a somewhat different pedagogical function from that of, say, the study centres in the Open University model.

4. 3. Projections over time

4. 3. 1. As mentioned earlier in section 3. 3. , it is extremely difficult to forecast which technologies will be widespread and how rapidly this penetration will take place. This applies in particular to the take-up of technologies for use in the home and in small businesses.

The most difficult forecasts to make cover the first five-year period. But experience gained so far suggests that the technology in general use in about 10 years time will no doubt be on the leading edge technology today. This is of particular importance to the renewal rate. In our calculations in the scenarios, we have made assumptions about the choice of technology available today, and have then extrapolated the cost trends for both technology and salaries.

4. 3. 2. Details of the basis of our projections appear in appendices III, IV and V. The general assumption for the projections is that salaries will increase by 2% per year; that the purchase price of hardware and software will generally fall by approximately 10% per year; and that costs incurred in relation to the use of telecommunications etc. (networks) will fall by 5% per year. These are, no doubt, very conservative estimates, and for individual technologies (eg video conferencing) for which all experts have unanimously predicted more drastic price cuts, the base line has changed correspondingly. The difficulty is to take into account non-linear price reductions. This applies both to when reductions will take place and to how drastic they will be. Given, for instance, that one hour's transmission time on satellite television currently costs approximately 12,500 DKK, and that the hourly rate in the USA is currently less than 500 DKK (because of the use of a special signal compression technology), and given that we also know that the Americans - due to the liberalisation of telecommunications in Europe - are intending to send up a satellite which will cover the whole of Europe and which is intended to be in orbit from 1994, then it is fair to assume that there will be a major price drop in Europe. When and how much rates will fall is, however, uncertain as this area is not completely open to free competition.

4. 3. 3. Another problem to do with the construction of the scenarios has been the transformation of Danish experiments to generalised models. Most of the examples the committee has been able to examine have been small-scale experiments. It goes without saying that in experiments there is a lot of trial and error and the breaking of new ground. Being all the wiser as the result of such experiments is an integral part of it all. For this reason, experiments are expensive and cannot be compared directly with efficient, everyday operations. This would be analogous to looking into the cost structure of a small one-man business and on that basis predi-

cting aspects of the cost structure of a large enterprise. Such scaling-up is simply not possible.

We could, of course, analyse experience gained abroad and use, say, American or Canadian technology-supported learning systems instead, but the differences in cost and course structures are so great that this is not a practicable solution, either.

4. 3. 4. Our point of departure in the scenarios has therefore been to assume that *new technology-supported learning modes are applied rationally and are in everyday, mainstream use.* In other words, the committee assumes that the models have overcome their teething troubles and that the initiative has a reasonable size. The scenarios thus reflect our best estimate of how such models would perform when the educational institution has acquired a certain degree of experience in running this kind of course and, for instance, finds the costs relating to the depreciation of equipment within their means when such modes of delivery are used to a reasonable extent. In the opinion of the committee, this is also the only method that can be chosen if trends in development of cost structures for technology-supported learning and traditional provisions are to be compared.

But reality is different. For quite a number of institutions, an increased use of technology-supported learning would mean breaking new ground, and this will inevitably have a price in the initial phase of reorganisation. On the one hand, wisdom acquired like this costs something and on the other hand, a running-in period must be expected before the equipment is used to such an extent that there are no additional costs.

The implication is, of course, that the economics of several of the experiments that have been studied are less favourable than assumed here, when comparing with traditional provisions. Such differences can be accounted for, but this does not in any way justify everybody still starting from scratch and failing to draw on common experience. Chapter 5 contains various suggestions as to how to carry out reorganisation without having to reinvent the wheel. They also contain the committee's strategies for the transition to the year 2000 and show how it is possible from the very start to obtain certain economies of scale and build on the slender body of national expertise.

4. 3. 5. One may justifiably claim that the basis for the projections is very loose, but the committee doubts whether this can be improved. The decisive figures at present are the costs incurred when setting up the infrastructure, initial costs to do with the purchasing and installation of hardware at institutional level coupled with the operational costs of the network for the first five to ten years.

Problems regarding the division between initial and operational expenditure are of importance today. If the Ministry of Education's construction activities were decentralised so that all construction expenses were to be delegated to the institutions, then the problem would be solved in the long term.

For further details of the calculations, see appendix IV.

4. 4. Scenarios for technology-supported learning 1993-2003

4. 4. 1. The committee has chosen to establish three scenarios, which together should cover the development of technology-supported learning in Denmark. The scenarios supplement each other, and they can be combined in innumerable ways.

When one looks at their individual components, it is characteristic that technology-supported learning increasingly seems to provide good opportunities for tailoring individual courses without costs getting out of hand as a result.

In particular, the scenarios concentrate on describing technology-supported learning as entire educational provisions based on typical learning contexts. As such, one of the advantages of new technologies is that they also increase the choices available so that learning can be adapted to individual needs and desires to a greater extent than before.

In its description of technologies in the individual scenarios, the committee has chosen to build on technology options with some following in Denmark. It means, for instance, that the transmission of sound, pictures and data are not normally expected to take place via satellite but via terrestrial (i. e. earth-based) networks. The new options of cheap satellite transmission time may very well change this prerequisite.

4. 4. 2. The three scenarios are all based on the same framework, shown below, making it possible to compare the three. The framework of the description appears in section 4. 4. 3.

We assume that the readers of the report will typically have a technological, a pedagogical or an administrative background and that very few will cover all three areas. This makes it very difficult to establish a common frame of reference in the description of the scenarios, so that the majority do not find the coverage given to their respective field of specialisation too banal and yet are able to cope with issues in other fields.

The committee has therefore chosen to supplement the description of the scenarios with a video of approximately 20 minutes' duration which both give examples of technologies and shows typical learning contexts for each of the three scenarios. The video builds on Danish experiments and fully-developed systems. It thus supports the scenario description for 1993, while no attempt has been made to include visions. For additional support for the description, please see the special appendices on technology (appendix VII) and on pedagogy (appendix VIII).

The scenarios may well seem like one-sided praise of technology-supported learning to the critical reader. He cannot be blamed for that, but it should be remembered that the very purpose of the scenarios is to show where technology-supported learning may be well-suited. We can also provide many examples of where such systems would not be suited but they can only be arrived at by a process of elimination!

4. 4. 3. The framework of the scenario descriptions

1. Description of the model
    flexibility as regards
    time
    distance
    access
    start time/pace of study
    "class" sizes

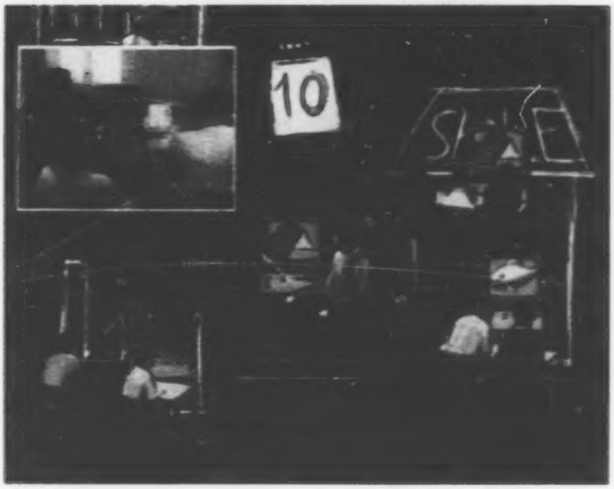
2. Target groups for which the model is best-suited.

3. Pedagogical advantages and disadvantages
    student roles
    teacher roles

4. Technology
    mix 1993
    mix 2003

5. Investment and operational calculations.

4. 5. Scenario I: time-independent learning



General description

4. 5. 1. time-independent learning has been known as a technology in the form of letters for thousands of years. Correspondence schools - or rather the mail-distributed education system - remains the backbone of the large distance universities' educational provisions.

The novelty of the time-independent learning model is that it is now possible to combine elements from classroom teaching with the temporal flexibility of the correspondence school. It is therefore not without reason that the time-independent learning model is often also called "the virtual classroom".

In the Danish version, the model builds on the principle that the individual studies either at home or at his place of work, both of which entail a continual dialogue with the teachers of the class and with the other students. This may take place by means of a telephone which the student uses to call the teacher or his fellow-students directly. The most appropriate solution, however, would be to use computer communication. This may either be in the form of electronic mail or, more likely, data conference systems or other electronic systems enabling several students to work in the same "electronic room". Today this is usually done by connecting a modem between the telephone and the PC. In the case of small classes, electronic mail is adequate, but in the case of big classes an educational method enabling students to learn primarily from each other is to be preferred. This necessarily presupposes that the students can go into the same "electronic room".

Our scenario builds on the principle that the student will always call the nearest educational institution which is connected to an educational network, and that the traffic is subsequently relayed to the institution which is responsible for the educational offer in question. Economically speaking, this means that we presume the student always only pays the rate for communication to the nearest institution (in the network) and that additional network costs are financed in other ways.

In the Danish version, study usually includes some courses with direct teaching, typically in the form of weekend seminars, normally approximately three seminars every six months. The purpose of the seminars is both to establish social contacts between teachers and students and among the students as such, and to use the seminars as the mode of delivery for the elements of the course which are best dealt with in the form of direct teaching. Seminars furthermore have a very strong influence when it comes to maintaining the study pace of the individual student.

Such seminars also mean that teacher(s), within limits, can modify course activities after a seminar, based on experience gained during the seminar itself. It is still a requirement that there be an overall plan for the entire course before it starts. The model does not, however, give rise to the streamlined (and often somewhat rigid) model which is required in, say, the British distance education system.

In the intervening periods, the students either work on their own or in groups. During these periods, dialogue takes place via telephone, a personal computer etc.

The model can be extended by one-way video (with sound). This model is, it is true, described in the scenarios in scenario 2 (simultaneously-distributed learning). But as most homes now have a video cassette recorder, the individual will be able to record broadcasts himself. In fact the model can also be used for time-independent learning. In the initial phase we build on the fact that one-way video is transmitted on a public broadcasting transmission network for instance in periods where the network is already operational. Another possibility is distributing audio or video cassettes by post.

As the title suggests, the model is well-suited for time-independent learning, i. e. that people are free to choose the day and time they want to work. To a certain degree it is independent of distance, but the added element of weekend seminars does, however, mean that there are some limits. If the model is scaled up to a global/European/national level the issue of distance could be solved by holding regional seminars.

At the present time, it is probably most appropriate to require that the student has access to a PC and a modem.

Although the model may be time-independent, the concept does however presume that the students are more or less at the same level. The model is thus not particularly flexible when it comes to start time and the expected study load during the course. Individual courses should no doubt be divided into a number of separate modules in order to allow the individual to adapt his course to the work load he is able to sustain.

The time-independent learning model has limited class sizes both as regards communications and the seminars.

For the computer conference part and the seminars as such, the maximum "class size" will no doubt be somewhere between 75 and 2,000 students, depending on the course organisation. There is, however, nothing to prevent the existence of several conferences running in parallel and thus much larger student numbers. In the case of substantial student numbers, it may well be appropriate also to divide the seminars into smaller regional groups with a maximum of 100 students per group.

Time-independent learning based on computer conferencing and direct teaching seminars is comparatively labour-intensive and will therefore have a built-in cost buoyancy, albeit to a lesser extent than the traditional instruction. In the long term, one must assume that an increasing proportion of the materials used during periods of independent study, either individually or in groups, will consist of computer-aided interactive learning programs (for further information, see scenario 3). This part of the system can work with unlimited course enrollments.

Target groups

4. 5. 2. The time-independent learning model is well-suited to all groups for whom learning has to fit in with a wide range of other daily commitments. It will be the appropriate choice for many families who have small children and where both parents have jobs outside the home, or for the single parent who has even greater difficulties in leaving the home frequently to attend school. The model is also well-suited for people in working life whose working hours and workload fluctuate a great deal, and for those who travel extensively etc.

The model gives an almost equal geographical opportunity of access to just about any course of education. It will thus be possible to increase education and training opportunities for the rural population in general, not the least in thinly populated areas and for island communities.

Each year, a very large number of applicants who are in their late twenties or more are turned down for higher education courses. Most of them probably have families and perhaps work and live at a fair distance from an educational institution. Quite a number of these will no doubt be interested in choosing an education and training course based on scenario 1 either on a part-time or on a full-time basis. This would probably allow much of the backlog of applicants to be cleared, leading to a significant increase in the possibility of reserving full-time study places at the institutions for young applicants.

For those who had been turned down, both part-time and full-time courses could be offered without any technical problems. In a White Paper on flexible learning published recently in Norway, there is a general recommendation that students following flexible learning courses at a normal pace and on a full-time basis should be entitled to student support. The committee finds that this issue does not fall within its terms of reference and has not taken a position on this matter. The committee has just drawn the attention to the problem.

The time-independent learning model is a mode of delivery which will be increasingly widespread in line with the increased use of personal computers in the home. It is characteristic that the time-independent learning model is also extremely popular in big towns, where there is a huge and varied supply of traditional options. This should probably be interpreted as a clear expression of the fact that the model lends itself to the lifestyle of the 1990s. Danish experience in this respect is also quite unequivocable. Generally speaking, people find it easier to be away from home at weekends agreed in advance and the intensity of being together during weekends is equally considered to be very productive.

Student and teacher roles

4. 5. 3. The model makes new and different requirements of the students. During some periods, students are to work entirely on their own. This requires maturity, motivation and a sensible organisation of one's day.

The time-independent learning model leads to a shift from oral to written communication in much of the course, and this has lead to discussions as to whether this form of teaching excluded less academically inclined groups. Developments at large in society generally speaking make it difficult for academically weak groups to cope. Furthermore, it will only be a question of a few years before computers, also those used in the home, will be able to handle the spoken word.

Finally, a number of experiments show that barriers to writing on screen-based systems are easily overcome, and that computers equipped with good spelling checkers give great relief to groups with spelling difficulties.

The role of the teacher will change considerably in this model. At first glance, the model may resemble traditional provisions apart from the fact that, as a teacher, one cannot as easily "sense the mood" and adapt one's lesson plans accordingly.

Here we touch upon one of the central issues in relation to traditional instruction: how well-prepared is a teacher for a lesson, and, given that he is, how good is he at adapting his teaching to the mood? Heretically one may ask: how much teaching is currently based on a lifetime of intuition and routine?

Adapting is not quite as easy to do in the time-independent model. Here the essential aspects of the course must be organised before the course starts. On the other hand, planning should not be so inflexible that experience from seminars cannot be taken into consideration. There should be no doubt as to which assignments and which course materials should be ready for the individual lessons. If it is a question of programmed learning materials, they must be available and have been tested before the start of the course.

The fact that the student is expected to work on his own also leads to the requirement that materials should be carefully thought out and foresee most of the predictable questions, so to speak. If some of the course takes place via a computer conference system, the students have an on-going opportunity of asking the teacher and each other questions. But experience also shows that they expect an answer within 24 hours.

If the teacher were to answer all these often closely-related questions individually, huge amounts of teacher time would be spent on this. The pedagogical task of structuring the course so that the students help each other with problems is therefore quite important.

The time devoted by the teacher to computer conferencing is also a decisive economic parameter, so it is important to provide for educational tools which allow the teacher to keep computer time at a low level.

Not only do independent study/group study periods require thorough preparation. Weekend sessions also require careful planning so that students find them meaningful. There will normally be more than one teacher in charge of a weekend event, so demands are also made of the teachers' ability to work as a member of a team. We must not forget, either, the many practical problems concerning board and lodging etc.

To sum up, one may say that this model not only makes great demands on planning and educational quality. It also makes the performance of the individual teacher and that of the teacher group highly visible in the eyes of students and colleagues.

Choice of technology

4. 5. 4. The individual technologies are described in appendix VII. They have therefore not been described here.

Technology mix 1993

As study primarily takes place in the home and at small places of work, the technical organisation of the course will depend on the equipment for handling sound, stills and data the student already owns. In Denmark in 1993, it will usually include:

- a telephone (possibly telefax)
- a radio
- a television
- a cassette tape recorder
- a video tape recorder
- (a personal computer)

The personal computer has been put in brackets, but it is probably already realistic to base the scenario on a home-computer connected to the educational institution or the private course provider by means of a modem.

Sound and (moving) pictures are today best distributed either by means of copies of audio and video-cassettes distributed by post or by radio/television transmissions. If the number of students exceeds 25-30, it is most appropriate to distribute via television. Technically, it is already possible to transmit course materials (text) via television. This can be done via data-broadcast, where a PC is connected to a television receiver.

The committee recommends that an opening should be found so that public television transmitters can be used to broadcast educational programmes and data for part of the period during which the test card is being transmitted. It should be possible both to broadcast the programs nationally and regionally as required.

The committee has been informed that, in connection with the parliamentary reading of the Radio and Television Bill, the former Communications Minister at a meeting of the government prior to the presentation of the bill made a commitment to the Minister of Education to review the Radio and Television Act when the report of the committee had been completed. The need for further amendments to the Act could then be ascertained.

The problems requiring clarification are whether educational institutions or the proposed electronic university may use the transmission network and retain the copyright of educational materials, whether the transmission of video of non-broadcast quality will be permitted, and whether such broadcasts can take place without considering legal editorial matters to do with the balance of output. Such clarification will also allow for more transmission repeats. Additional issues needing investigation are whether there are problems to do with the use of local and regional stations, and whether their transmitters may make simultaneous broadcasts for educational purposes.

After the year 2000, personal computers in the form of multimedia workstations can be assumed to be in widespread use in the home. It will also be possible to use radio/television as links in digital communication. The availability of ISDN (and its successor) in almost every home can also be assumed. The book in its physical embodiment will not have disappeared, but huge information databases will no doubt be connected to the educational networks from which the student can draw material. Computer conferencing systems with user-unfriendly user interfaces will no doubt also be a thing of the past. It will probably also be possible to choose to communicate by talking or writing via the network.

Finally, we will probably have reached a situation in which courses for use in the home will have become subject to global competition. Large-scale international multimedia producers will offer courses in almost anything via (electronic) mail order. Some parts of the courses will still be in English only, but the bulk of them will be available in a Danish translation.

Economics

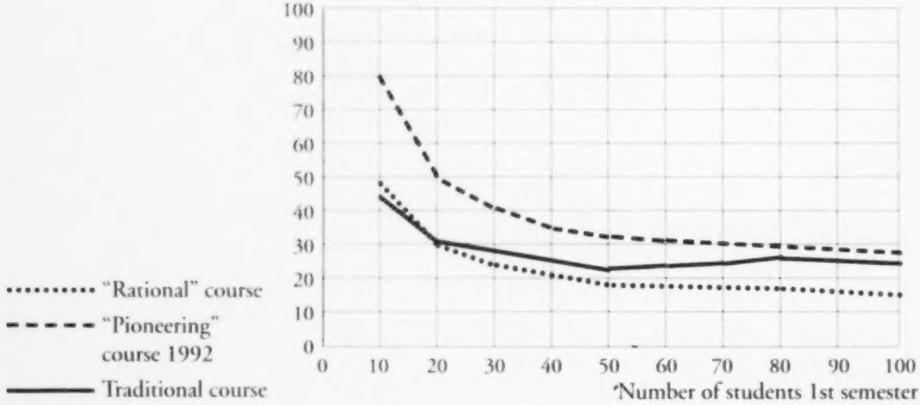
4. 5. 5. In scenario 1, we have only reviewed models based on communication via computer conferencing. As previously mentioned, it will be possible to complement the concept by distributed videocassettes or by television broadcasts recorded with a video cassette recorder by the individual (such examples are covered in scenario 2). It would also be appropriate to install a supporting toolkit in the form of Computer Based Training (CBT) programs and information databases in such a system (such examples are covered in scenario 3). They variants have not been included in this account of economic issues. In the following, we have only selected examples of the computer conferencing model used alone.

This economic model is based on the supposition that students buy their own PC and a modem, and pay their telephone bill as well as expenses in relation to books themselves. This already applies to a number of adult education courses. But in some adult education courses, course materials are made available free of charge. For such courses (e. g. general adult education, higher preparatory examination and labour market training courses), the initial costs will be considerably higher. With the expected price cuts for technical equipment, the difference will, however, diminish with time.

The scenario is also quite sensitive to the number of teacher hours required. The most important elements are the development and maintenance of the courses as well as the so-called teacher screen time (i. e. the number of hours the teacher devotes to computer conferencing). It is our opinion that, by including a number of seminars in the course of a term, it will be possible to reduce pre-course planning considerably, because it will be possible to make adjustments along the way. Similarly, we find that the sensitivity to teacher screen hours is largely a question of pedagogical techniques so that the teacher does not devote all his time to answering individual questions but wherever possible puts questions to the whole group (so-called peer learning).

In figure 9 below, we have shown the unit costs per student in the ED-programme in 1992 (a part-time bachelor's degree programme in languages) based on computer conferencing with low development costs and low teacher screen time, the actual unit costs of the South Jutland Business School ED-programme based on computer conferencing in 1992, both of which are compared with the costs of a traditional ED-programme offered by the Copenhagen School of Business. All offer a programme in English. The School of Business offered the ED-programme for the first time in 1991, so it is as a matter of fact a fairly new educational provision. As it was the first time that an entire degree course was offered in the form of a computer conference in Denmark, it is in many ways a pioneering effort with considerable "learning by doing", which naturally enough is reflected in the costs.

Figure 9. Costs per student in 1992 for the ED-programme of various class sizes and different modes of delivery

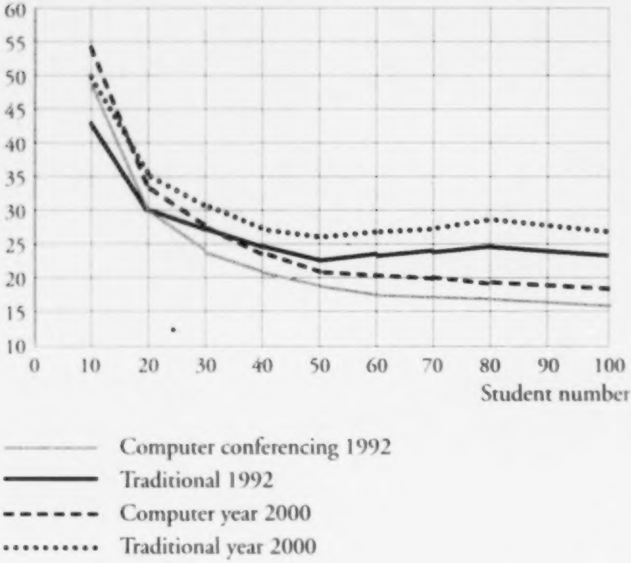


The computer conferencing scenario can be described as a "small-scale scenario". The economies of scale begin to flatten out at 200 students, although the unit costs do, however, continue to fall. At the same time, it is a model in which an increase in student enrollments above this number may lead to a number of practical/ organisational problems. Compared with the traditional provision, ED in "rational" conditions may currently be implemented at the same unit cost for the first 20 students, after which it becomes cheaper than the traditional provision. When compared with the actual unit costs of a "pioneering" ED-programme offered in 1992, however, the latter, even with a very large class, will be more expensive than the traditional provision. But it will be possible to reach target groups who would otherwise not have been able to participate in the course.

If we make extrapolations to the year 2000, units costs will increase in fixed prices both in the traditional provision and in the computer conferencing mode of delivery. The latter is due to the fact that computer conferencing is also a rather labour-intensive model. It is, however, worth noting that the costs of the traditional provision will increase the most. If we compare the unit costs of the "rational" model with those of the traditional provision, by the year 2000 the computer conference model will have lower unit costs with course enrollments of approximately 18 students.

Figure 10 shows the unit costs per student in the diploma-course in economics in 1992 and the year 2000 for a computer conference mode of delivery and a traditional provision respectively.

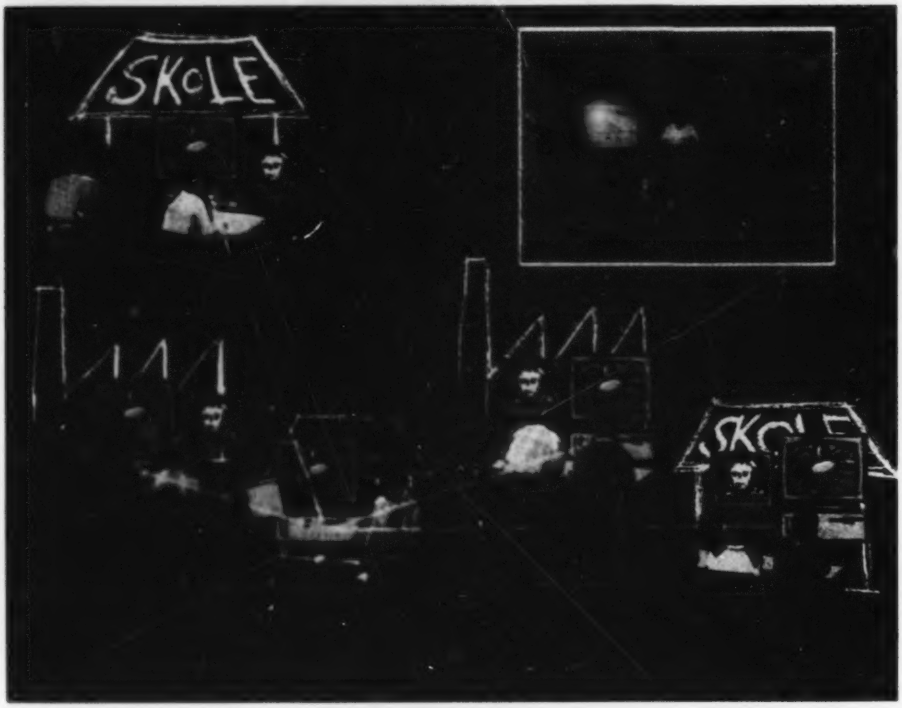
***Figure 10.** Comparison of unit costs in 1992 and in the year 2000. The costs for both the computer conference model and the traditional provision are expressed in constant 1992 prices*



Although the computer conferencing model in this figure is relatively labour-intensive, had we selected other prerequisites, it would have turned out to be significantly cheaper than the traditional provision. It is thus a model which in real terms reduces the need for school buildings. In a situation where educational capacity needs to be increased, (and where it is estimated that the initial cost of a study place is 100,000 DKK), this model will require a much smaller investment than an extension of traditional provisions. (Depreciation on buildings is not included in the traditional provision in the figures above).

At the same time it is a model which offers the individual student considerable savings in transport and time. This aspect has not been quantified in the calculations, either.

4. 6. Scenario II
Simultaneously-distributed learning



General description

4. 6. 1. As opposed to the time-independent learning model, the simultaneously-distributed learning model is of comparatively recent date. It only started gaining ground after the Second World War.

The model is based on the principle that students can simultaneously hear and/or see a teacher either individually or in groups. The mode of delivery moreover distinguishes itself from television/radio courses in that there is a simultaneous dialogue between the teacher and students. The model which is not as yet common in Denmark is used to a much greater extent in countries such as Australia, Canada and the USA.

In models which from a technical point of view are based on satellite or cable television, the students can normally see the teacher, whereas the teacher cannot see his students (apart from those who are in the same classroom as he is).

Simultaneously-distributed learning is, in principle, an important element in for instance the British Open University, where television broadcasts have been combined with independent study material. The weakness in this mode of delivery has been the lack of immediate feedback from the student to the teacher, and television broadcasts have therefore gradually become more important as taped broadcasts in support of time-independent learning, as mentioned in scenario 1.

This does not mean, however, that television as a medium of distribution can as a matter of course be said to be outmoded. On the contrary, a number of new opportunities for linking television broadcasts with data communication seem to pave the way for a changed and strengthened use of television for simultaneously-distributed learning.

As opposed to video-conferencing systems which have clear advantages in relation to the teaching of small classes, television is just as evidently a large-scale communication medium where one needs a sizeable number of students before it becomes economically viable to use.

As television as a medium of instruction is presumed to be familiar, it has not been described in any detail here. In section 4. 6. 5. , we have, however, described both the economic structure of TV broadcast courses and of video-conferencing systems.

In new systems which are based on ISDN, for example, the teacher and the students can see each other, talk to each other and exchange data. There are two possibilities: so-called point-to-point communication in which two classrooms are connected, and one-to-many communication in which the teacher and students in one classroom are connected to a number of classrooms at other sites each with a group of students only.

Distributed learning courses based on cable or satellite television are often mass education systems although they may also, of course, be implemented with small student numbers. Distributed learning based on videoconferencing on the other hand is typically a mode of delivery which is appropriate when there is only a limited number of students at a given site. Many of the fundamental qualities of this form of two-way audio and video link such as the potential for real dialogue are lost when student numbers swell.

Other modes of delivery are based on simultaneous data communication and telephony but without video. Today, simultaneous oral dialogue normally only takes place in the form of telephone lines to a studio so that all students in the "class" can hear the questions and answers. Further possible extensions are that the teacher can answer questions via electronic blackboards or computers etc and extend the the scope of instruction. In this way it is also possible to exploit the advantages of scenario 1 and also work with time-independent dialogue as a supplement.

The simultaneously-distributed learning model is based on the principle that individual institutions which participate in a given distributed learning initiative and which thus function as study centres are linked together in a data network. The model is also well-suited for on-the-job training, and here the business enterprise is also expected to be linked to the educational institution. The sophistication of the connection depends on the amount of data capacity needed in the configuration. If pictures of a good quality are to be transmitted, an ISDN-2 link is needed. This is now sufficient because compression technologies have been improved.

Distributed learning is the technology-supported learning model which most closely resembles the traditional classroom situation. It can be supported by computer conferencing, allowing for the formation of student groups who work jointly on written assignments regardless of physical divisions into classes.

A third possibility is that the educational institution uses expensive hardware located in companies and in other educational institutions so that the students can control the equipment either simultaneously or time-flexibly from their place of study by means of networked control panel. Similar opportunities will no doubt soon appear allowing users to pay for access to huge international simulators.

Unlike time-independent learning, this mode of delivery requires that instruction takes place at predetermined times just like traditional provisions. As is the case in scenario 1, it may of course just be supplemented by independent study in the form of interactive course materials (from scenario III), the basis of which is also data communication, an increasingly common phenomenon. As has already been mentioned, it also allows for the inclusion of elements of time-independent learning.

The model is good at transcending distances which also explains its popularity in relatively thinly-populated areas where it may well be an appropriate form of "traditional" instruction.

Whereas time-independent learning takes place at home and at (small) places of work, the concept of simultaneously-distributed learning is normally based on relatively expensive equipment which is rarely available in the home or in a small business. For this reason instruction normally takes place at an educational institution which thus functions as a study centre, or at a large enterprise. At the same time, study centres will normally be equipped with other advanced technology-based teaching equipment such as multimedia, a substantial library of interactive study materials and recorded lectures.

This implies that lengthy trips are avoided and that both time and money are saved, but transport to an educational institution or the like is still required. If the course takes place at a place of work, it normally takes place during and/or immediate before or after normal working hours.

As far as the starting date/course start is concerned, the model corresponds to traditional provisions.

As far as class sizes are concerned, it is probably not worthwhile to work with "classes" or more than 50 students all told. It will also probably be impractical to link more than 5-6 sites for a joint lesson if there is to be a continual dialogue during the course. If class sizes exceed this figure, the instruction will correspond to the traditional lecture form where there is also frequently only room for one or two questions at the end of the lecture. If followed up, however, with open computer conferencing (or a BBS, a Bulletin Board System), where the students can ask questions and other students (possibly the teacher) can answer them, then class sizes of up to 200 or more will probably not be unrealistic. (It is technically possible to link up to 240 sites together, but the advantages of the model of direct "spontaneous" dialogue will presumably disappear if so many sites are linked together simultaneously. And it would also be very expensive).

Target groups

4. 6. 2. Simultaneously-distributed learning is a well-suited model in cases where the number of students at a given place of study is so few that it would be difficult to establish an educational provision either for economic reasons or for lack of qualified teaching staff, e. g. in thinly populated areas, on islands, but also in cases affected by isolation for instance hospitals, prisons and the like. It both applies to courses organised on a part-time and a full-time basis.

The model can also give students enrolled in ordinary courses a wider range of choices at more or less all educational levels from post-compulsory to long post-graduate courses of education. And not insignificantly the model makes it possible to offer subjects which would otherwise not be economically viable in many places, and to which the taximeter grant system would therefore contribute indirectly. And the practice that most study centres also provide opportunities for independent study in the form of training diskettes and recorded lectures will also provide increased opportunities for individualising the course and of providing increased support to slow learners.

The fact that there is normally a visual connection between teacher and students also makes the model well-suited for students or employees who are working on topics where it is essential to be able to see and discuss objects. In the long term these opportunities will however be available in the time-independent learning model, when computer networks obtain such a transmission speed and capacity that they can send pictures and sound of high quality at reasonable prices to ordinary households and small businesses.

When used as on-the-job training the model also provides obvious advantages for businesses - also including large-scale international concerns - which will be able to save considerable time wasted on travelling and thus also reduce travelling and accommodation expenses in this way. The same applies to public-sector employers and education and training courses which include compensation for travelling and accommodation expenses.

Video-conferencing technology had its "breakthrough" in connection with the Gulf war when many international businesses introduced a general prohibition on air travel. In its place, many chose to hold necessary meetings in the form of video conferences. Since the war, many meetings are still held in the form of video conferences, and companies thus save both travelling time and expenses.

Student and teacher roles

4. 5. 3. Student roles do not differ much from those of the traditional provision. It is often deemed to be an advantage that the students who are not present in the same room as the teacher can discuss what is going on during the lesson. This also reduces the need for clarifying questions, and that is why the class size can be increased. Another positive effect for adults who have used the system for, say, on-the-job training, has been increased general qualifications when it comes to working in groups.

It is probably not expedient to place younger students in a classroom without supervision, and in the case of adults one must generally assume that a minimum of motivation is present.

The demands made of teacher roles probably do not differ significantly from those made in traditional provisions, even though teachers have to learn to move in front of a camera. It has been possible to note that the conventions of visual media rub off psychologically speaking on students. They expect the sophisticated shooting angles and cuts of television and film, and thus expect a higher entertainment value from visually-based instruction than from traditional provisions. As regards visually-based instruction, greater demands are thus no doubt made of the teacher that instruction should be more varied than in traditional provisions and that it should include cuts etc. In newer video-conferencing studios, the teacher is normally able to cut from one camera to another, and to control video sequences and optional PC capabilities himself. To make full use of these capabilities does, of course, require some practical training as does appearing in front of a camera.

It is however the assessment of the committee that the increased use of video telephones in society will reduce the students' need for "entertainment".

Administratively, the video-conferencing model requires new patterns of cooperation. Joint timetables must be made by the participating institutions. Agreements must be made regarding the distribution of receipts and expenditure. They may need to decide what to do in the event of telephone breakdowns (as the model builds on video telephony). Is it, for instance, necessary to make video copies of all lessons and should they be made generally available to students for revision etc? Finally, there will no doubt be parts of the course such as laboratory exercises and the like which are not suitable for video-conferencing. How is this part of the teaching to be organised and what consequences will it have for the overall organisation of the course?

Choice of technology

4. 6. 4. As it is a question of specialised equipment for large-scale businesses and for institutions, clearly the possibility exists of using solutions which are more technically-advanced than those commonly in use in the home. As the committee assumes that satellite technology will be used neither for transmission nor for reception (cf. however 4. 6. 5. , from which it appears that at lower transmission costs satellite technology will be quite competitive), it is currently possible to foresee that modes of delivery will be based on video equipment, the telephone, and possibly computer networks, possibly including facilities such as electronic bulletin boards.

Network connections can currently be based on an ISDN-2 connection, but network solutions running at higher transmission rates are also a possibility, if the price is competitive. The EU is currently working on a high-speed network, the aim being 34 Mbit/sec at present. USA and Canada have plans for a network with speeds of more than 2 Gbit/sec. Whether it is worthwhile to use a public network or rented lines is a question of both data security and the volume of traffic in the network.

This type of technical equipment cannot be expected to be found in the home. It will normally be found in an institution or in an enterprise. Video-conferencing equipment will, however, fall rapidly in price, and one can assume that it will be widely used for teaching purposes amongst other things within the next ten years.

If one looks towards the year 2000, major changes will no doubt have taken place on the network side, and networks will have a far greater capacity than today. They will also have come down in price and they will be global. The "technical" obstacles to trade which today consist in the fact that crossing national borders costs extra will no doubt also be gone.

Simulation technologies in the form of "virtual reality" will also no doubt be an important global commodity for training purposes, just as access to enormous global databases will be an everyday occurrence for most institutions. As technology becomes cheaper, the centre concept itself will no doubt also change in character and to a certain extent become more of a distributor of services.

Economics

4. 6. 5. Similar to the time-independent learning model in scenario 1, the simultaneously-distributed learning model can also be organised in a great number of different ways. Assuming that students meet at the same time, and that there is a teacher at one of the sites, the computer conferencing model becomes, for instance, simultaneously-distributed learning. The consequence of organising a computer conference as simultaneously-distributed learning, seen from the course provider's point of view is that the model becomes more expensive, because personal computers, modems and communication expenses are now to be

paid for by the course provider and are therefore presumed to form part of the cost calculation. It is also more expensive to have a teacher available in all the lessons instead of there only being teachers present at seminars.

From a societal point of view, the model may however be cheaper because more students can share a personal computer. Basically the model does, however, have the same cost structure as in scenario 1, and it is therefore not dealt with in further detail here.

The committee has instead chosen to describe the cost structure of two different types of simultaneously-distributed learning. The first type currently requires very large student numbers in order to be economically viable. The second one is a model which is based predominantly on the principle that teaching which has until now not been economically viable may become so, or at least give a greater marginal return towards the costs of an institution.

Large-scale model based on courses using television broadcasts

The decisive factors here are production and transmission costs. In the case of television programmes produced to professional standards allowing for their inclusion in the normal transmission schedules, the price per hour may be very high. 500,000-600,000 DKK for a programme of 45 minutes' duration is not an unrealistic figure. It goes without saying that the development of educational broadcasts at such a price requires very large audiences before they become economically viable. Experience shows that educational programmes are popular, and there are also Danish studies which show that even with high production costs is it possible to obtain low costs per viewer per hour (cf. for instance Joan Conrad's study of the open university courses which have been conducted in a cooperation between Danmarks Radio-TV and the University of Copenhagen).

Normally educational television broadcasts do not stand alone. They are usually supported by printed study materials. These have traditionally been distributed on paper, but today printed materials can also be broadcast via text-TV so that the students can receive teaching materials at workplace or at home, if their computer is connected to a television.

As we have taken the scenarios in "active" teaching situations as our point of departure, the prerequisites cannot be the passive audience figures. But a yardstick for activity could be the number of viewers who buy the published study materials. It would probably be reasonable to look at the unit costs for an active audience of up to 10,000 students. These may either be students who follow the course at one and the same time or students following the course which is repeated several times with lower student numbers on each occasion.

In the following figure, the committee has not looked at the proportion of costs per student lesson accounted for by printed independent study materials; we have only looked at the costs of producing and transmitting the television broadcasts.

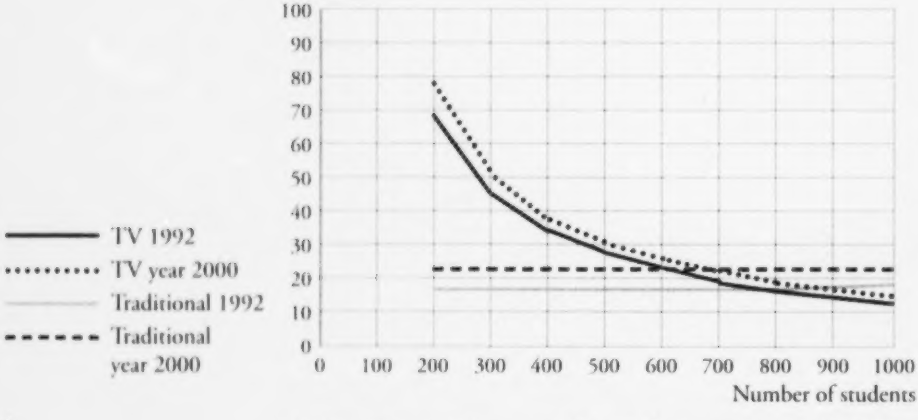
An educational broadcast if produced to professional standards could, as previously mentioned, very well run up production costs per hour of 500,000-600,000 DKK. With an audience of 10,000, this would mean a price per student lesson of 50-60 DKK, to which should be added the transmission costs.

In figure 11, we have compared the unit costs for educational broadcasts in 1992 and year 2000 with the unit costs per lesson in traditional provisions. In the example it is not a question of professional television quality but of simple video recordings. Compared with the above-mentioned prices of a televised lesson (=45 minutes), the production costs per lesson have been estimated to amount to 6,270 DKK which is probably rather low. The basis of the calculation is that the course is only held once. The example shows the unit cost (i. e. per student) for one lesson. No overheads for examinations, administration etc. have been included, as it would blur an understanding of the cost structure of the television medium in itself.

As a lesson in traditional provisions typically costs 12-25 DKK, it will be seen that educational broadcasts in 1992 will not become cheaper until the student number exceeds approximately 800 students. Above this figure, educational broadcasts are cheaper. It can be seen that unit costs fall with increasing student numbers.

If we project the unit costs to the year 2000, educational broadcasts will have become a little cheaper than the traditional provision in relative terms, and the intersection point now lies closer to 700 students.

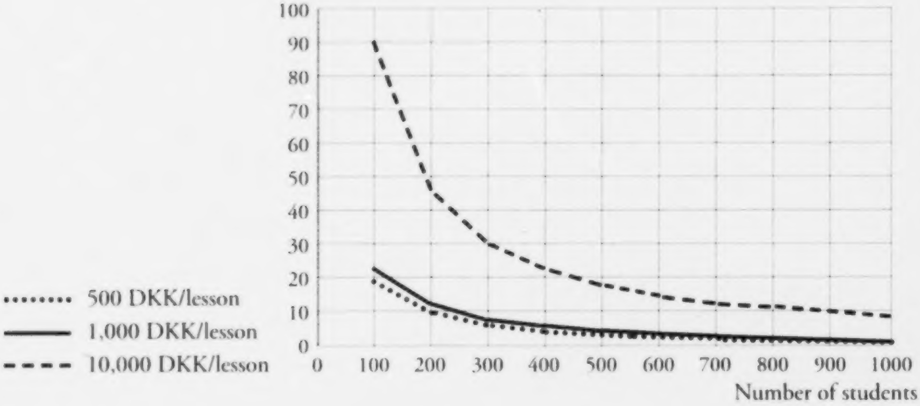
Figure 11. *Unit costs per lesson for educational broadcasts in 1992 and in year 2000 compared with traditional provisions*



Note: *Transmission costs for 1992 amounting to 10,000 DKK per lesson are expected, and teaching materials are only expected to be issued once. In the traditional provision in 1992, the maximum class size is presumed to be 25, and 2. 5 teacher salary lessons of 180 DKK per lesson are presumed to be used.*

With unchanged transmission costs, unit costs will thus increase towards the year 2000 as salaries account for a large share of costs. Transmission costs do, however, constitute an uncertain factor in areas where it will be possible to change over to the new compression technologies already on the market. It will thus probably be possible to reduce transmission costs from 10,000 DKK/lesson to 500-1,000 DKK/lesson. Figure 12 shows what this would mean for the unit costs per transmitted lesson in 1992.

Figure 12. *Unit costs in DKK in 1992 of one educational programme with transmission costs of 500, 1,000 and 10,000 DKK per programme and the distribution of materials 4 times*



In the calculations on which the figure is based, as opposed to the previous figures, it presumed that the course is repeated four times. With transmission costs of 500 DKK/lesson it appears that educational broadcasts will cost the same as traditional provisions for approximately 100 students, and be much cheaper for 200 students.

If we, for instance, assume that 250 students a time will follow a course, which is repeated 4 times, the transmission costs per student lesson will be 2. 30 DKK.

Small-scale model based on video-conferencing

The other model which has been the subject of calculations is a model for decidedly small-scale instruction, typically instruction with classes of from 2-3 to 8 students per class. It will thus cater for courses which most institutions do not currently offer because with the existing taximeter structure it is too expensive to provide. It may, however, also be something which the institutions are obliged to offer, because it contains subjects which are obligatory in certain courses. In such cases, when organised as traditional instruction, this small-scale instruction will give the institution a considerable negative marginal income.

There may of course be situations where one can imagine an entire degree course organised in this way, e. g. in the provision of education to island communities and the like. The typical situation would be, however, that a limited part of the course offered by a given institution will be organised in this way. In our calculations, we have assumed that the teaching equipment is used for a total of 1,200 lessons per year, also including teacher conferences etc. If we compare this with the annual teaching activity of a comparatively large vocational school, a utilisation rate of 1,200 lessons will correspond to a few per cent of the instruction being organised in this way. At a smaller institution which has difficulties in setting up classes which are economically viable, the utilization rate will no doubt be significantly higher, but it would hardly constitute more than 10-20% of the activities of even a fairly small vocational school.

As already described, the model works as follows: a teacher has a normal class at a school, and at the same time other small classes (without a local teacher) at sites all over the country take part in the course. It is therefore decisive from an economic point of view that it is possible to use the teacher salary expenses "saved" to cover the costs incurred in connection with the purchase of technical equipment, the ongoing transmission costs as well as depreciation which depends on the presumed utilisation rate of the equipment.

If we calculate in this way, table 8 shows how much cheaper it will be per student-year to offer the higher commercial examination course using the video-conferencing model compared with the traditional provision. The higher commercial examination course is a comparatively cheap course. If we were to choose a more expensive course, the economies would be even more significant.

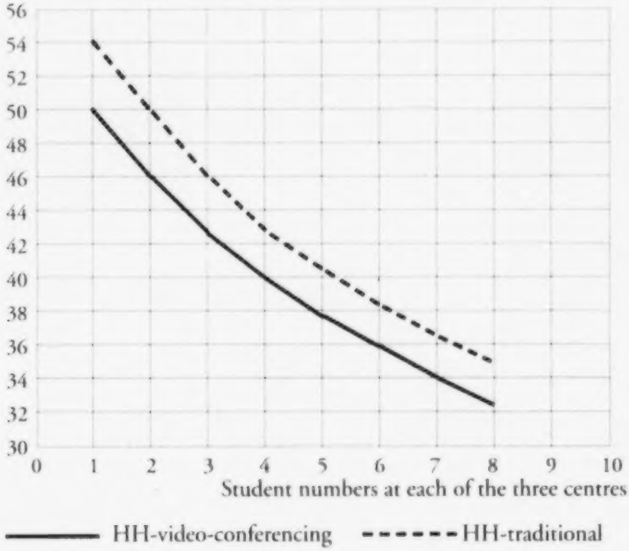
Table 8. *Annual savings in costs per student in DKK for the higher commercial examination course with 26 students at the main centre when choosing video-conferencing rather than the traditional provision*

Number of centres	Number of students 1	Number of students 4	Number of students 8
1	÷ 1.295	÷ 1.165	÷ 1.020
3	÷ 4.825	÷ 3.685	÷ 2.803
5	÷ 14.904	÷ 10.041	÷ 6.998
7	÷ 23.762	÷ 14.522	÷ 9.562

If the course *had to be* offered, the choice of video-conferencing would thus right from the start provide the institutions with a higher marginal income than small-scale courses offered in the traditional way, given existing cost structures.

With the present taximeter grants to, for instance, the higher commercial examination course, this mode of delivery will still be too expensive, however, if the entire course was to be organised in this way. In figure 13 we have shown the unit cost per student lesson for the higher commercial examination course in 1992 for the traditional provision and for the video-conferencing option.

Figure 13. Unit costs per lesson in 1992 for the higher commercial examination course when organised in the traditional way and by means of video-conferencing.



Note: It is assumed that 26 students are being taught at the main centre from where the video-conferencing course is transmitted, and that students are being taught at 3 "teacherless" local centres.

The taximeter grant to the higher commercial examination course in 1992 amounted to 28,400 DKK (excluding a grant for overheads), but from this should be deducted expenses in relation to acquisitions and the like, leaving only 26,900 DKK per student per annum. This figure corresponds to a gross costs per student lesson of approximately 24 DKK. The video-conferencing model will thus as an entire course only "pay off" today when there are no alternative modes of delivery within the existing taximeter structure. In such cases, it will probably be a question of a political decision. But on the other hand, it appears that video-conferencing, given a reasonable utilisation rate, will provide a higher marginal income than the traditional provision in the case of small class instruction which the institution either wishes or is obliged to offer.

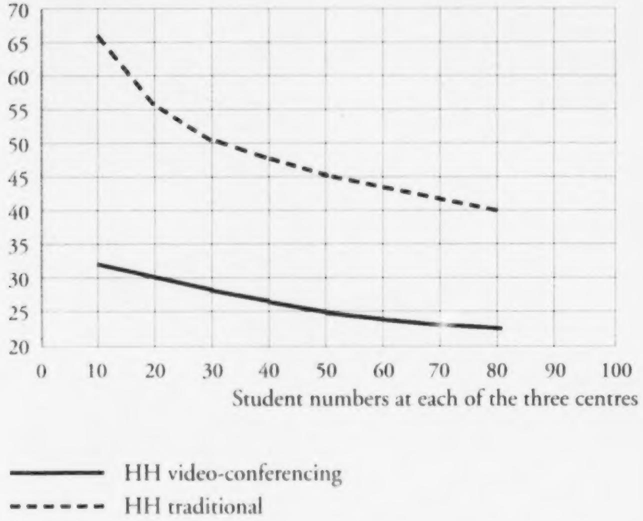
If we extrapolate these trends to the year 2000, it is of crucial importance to the calculation whether the expected decrease in the acquisition of equipment turns out to be the case. Most experts expect that the costs of purchasing this type of equipment will fall drastically in the coming years. An annual price fall of 25% is anticipated (parts of the equipment have thus already fallen by 20% since the calculations were made two weeks ago!).

If this holds true, this means that the percentage fall in unit costs for the video-conferencing model will be of the order of approximately 35% for the period 1993-2000.

In figure 14 we have shown the unit costs in the year 2000 for the video-conferencing model and the same course organised in the traditional way. The unit costs are indicated per lesson.

In appendix V it has already been calculated that (according to the budget assumptions of the N{stved College of Commerce) the taximeter grant towards instruction in the higher commercial examination courses in year the 2000 must be increased by 17%, if present educational standards are to be maintained. This would mean a taximeter grant in year 2000 of 31,473 DKK per student-year for the expenses which are being compared here (and gross student lesson costs of approximately 28 DKK). This will therefore mean that in the year 2000 it will also be possible to organise entire courses for some of the combinations based on the video-conferencing model at lower unit costs than in traditional provisions.

Figure 14. *Unit costs per lesson in the year 2000 when organising the higher commercial examination course traditionally and by means of video-conferencing*



Note: *It is assumed that 26 students are being taught at the main centre, from where the teaching is transmitted via video-link and that students are taught in 3 "teacherless" local centres.*

The projection for 1993-2000 is based on the following assumptions:

(1) Constant price level
(2) Salaries will increase by 2 per cent per annum
(3) Prices of video conference equipment will fall by 25 per cent per annum
(4) Transmission rates and use will fall by 5 per cent per annum
(5) Student-dependent costs will remain unchanged.

4. 7. Scenario III:
The independent study model/individualised instruction

General description

4. 7. 1. Independent study models are characterised by the fact that, in principle, the student works alone with the subject-matter. In principle it is a model which has existed for as long as there have been books. Normally the independent study model differs from the mere reading of books in that it presupposes a planned course of study.

In principle, the model builds on the fact that the course participant is to be able to find answers to all his questions in the study materials. The model requires carefully-prepared course materials. Such materials normally have a lengthy production period, and require several evaluations on "pilot-course participants" before one can be sure to have ascertained the most typical questions. As this is almost impossible, the model is frequently supplemented with the possibility of study support in a study centre. In recent years, students have often been given the additional possibility of asking questions via computer networks or telephone/telefax.

Scenario 3 thus resembles the time-independent learning model, and in the course of time the two will no doubt gradually merge. Currently there is a salient difference, because the model is based on the individual working on his own and at his own pace.

The independent study model is undergoing a rapid development, thanks to the new media. As early as the 1960s there were programs with computer-supported learning, but they were never a great success. They were criticised for only being able to handle simple training situations, and because the dialogue between the student and the machine was confined to yes/no or multiple-choice answers. Computer-supported learning was exclusively text-based, and it was normally linear, i. e. it was not possible to skip anything in the course.

Technological developments have meant that the "dialogue" between the course participant and the machine is now much more varied. Many programs can assess whether a spontaneously written answer by the course participant is right or wrong. The programs can assess the course participant's level of attainment and tailor the instruction to the level of the individual course participant. The students can move freely within the course, and the programs can hold the final examinations themselves.

With the breakthrough of videodiscs and, in particular, CD-ROM technology which is on its way into the consumer market one can anticipate that there will be a rapidly increasing supply of high-quality independent study materials in the coming years, at least as far as the English-speaking market is concerned. Such materials will probably be available in Danish versions to a certain extent, too.

As mentioned previously, independent study is defined as a planned course of study as opposed to the mere reading of books. The boundary will, however, become increasingly difficult to define. Generally speaking the new media will probably not replace books, but they will be offered in combination with books (grammars/ training programs in mathematics, simulations etc.). In some areas they will either appear and totally replace books (electronic magazines), or there will be a choice between a publication in paper and electronic formats. This will apply to almost all works containing considerable amounts of information, e. g. encyclopedias, compiled works in many areas, textbook systems for a number of subject areas etc. Such media can disseminate text, images and sound. They can animate and show how a process takes place, and there will probably not be any problems incorporating educational sequences.

Characteristic of such media are the enormous amounts of information which can be contained on a single disc. The rapid access and the opportunity to conduct combined searches mean that a reader can claim that he is able to carry on a dialogue with a book!

One of the problems involved in the production of videodiscs and CD-ROM has been the very high development costs for the production of the first version. One of the reasons for this has been that considerable amounts of information have often had to be translated into a machine-readable form, so that it could be stored. There have also been huge development costs to do with the organisation of knowledge on the discs. Development will continue to be expensive, but costs will also fall here, and an increasing proportion of the information will already exist in digital form. To this should be added that titles are now close to being produced in large quantities - at least in the international market - because the formats involved are making their way into the consumer market. For all other information technologies this has so far meant rapidly falling prices.

Given that development costs for multimedia are still high, we have in our calculations for scenario 3 both made calculations for an independent study model based on independent studies using an ordinary PC - the so-called CBT (computer based training) - and an independent study model based on multimedia, and which thus in addition to a PC also requires a videodisc or a CD-ROM. Seen from a purely organisational point of view, there is no reason for the models to be different. Multimedia are only more sophisticated, technically speaking. They require more expensive play-back equipment and are also even more expensive to produce.

A number of companies are now developing (or commissioning) technology-based teaching material for continuing education and training themselves. For some of them, it will probably be more advantageous to be able to choose a tailor-made product at a somewhat lower technological level (assuming that the product can meet almost the same pedagogical objectives as a multimedia product) rather than choose a more standardised product based on multimedia technology. With new author tools, such teaching programs will be cheaper and cheaper to develop.

What we have here is a mode of delivery which theoretically offers total freedom when it comes to delivering the course when it suits the individual. This freedom is, however, restricted today by the requirement that the necessary equipment and peripherals must be available. It still restricts the use of advanced multimedia - at least for use in the home. Although some computer-based training will no doubt still require more powerful computers (normally a 386 processor as a minimum, but preferably a 486 processor) small personal computers will be able to manage.

For these reasons the course participant who wants to train by means of advanced multimedia is restricted to studying during the opening hours of, say, a study centre, company or media workshop. The full time-independence of the independent study model is thus only achieved when the student can freely choose to study at any time of the day or night. The model is clearly based on the principle that the student should be able to study at his own pace.

Theoretically the model can operate with unlimited class sizes. As the replication costs of a diskette or a CD-ROM are low, the profit will be very high once the development costs have been covered.

Another variable which is probably very Danish is that independent study materials are used in a study situation where there is still a teacher present during the course, and where independent training situations are often combined with sessions of traditional instruction. In these teaching contexts, the teacher role changes into that of consultant. He thus becomes a resource person, to whom the students will be able to turn for assistance as and when necessary. It is obvious that in such learning models there cannot be unlimited class sizes. But it will still be possible to use independent study material for many classes and it will thus still be possible to obtain economies of scale.

One might ask whether the model is also economically viable in situations where there is still a teacher present.

Four forms of experience already seem to have crystallised.

- The teacher in the role of consultant can manage bigger classes than in traditional provisions, provided that teaching materials are well-organised.
- The instruction time can apparently be reduced by about about one-third.
- Course participants get higher scores at the final examinations than those who have attended equivalent traditional provisions.
- Learning outcomes such as long-term retention are also clearly greater than on completion of traditional courses.

The added cost of having a teacher involved may thus be recovered, among other things, through fewer course days and a greater proficiency (lower error rate) when what has been learnt has to be put into practice.

Target groups

4. 7. 2. As a global concept, the model in its pure form is well-suited to people who primarily wish to study at their own pace. As mentioned in the introduction, until now the independent study model has underpinned the adult education tradition of the English-speaking world.

Such needs do, of course, also exist in Denmark, but in the committee's opinion they are not so pronounced because the Danish tradition of learning - as mentioned in section 4. 2. 1. - is characterised by people wishing to share subject-related content and thus study together at a given pace. This reservation holds true in particular in the case of long degree courses. As far as short courses of one day to one week's duration are concerned, independent study materials will no doubt gain ground in Denmark, too.

Apart from being a suitable model for short courses, an increased use of independent study materials will, no doubt, be suitable as modules in traditional provisions. Making interactive materials available will provide opportunities for tailoring the course which the course participants can use at their own pace and for as long as they wish in order to acquire the necessary skill in, say, the conjugation of French verbs, the solution of mathematical problems, studying geography, or driving a train and so on.

Many of the programs will also be well-suited for the training of academically weak students and for people suffering from reading disabilities. It is no longer necessary to "talk" with machines by means of complex commands. This can be done by clicking on a "mouse", by literally pointing at the screen or, for instance, by using a light pen for reading bar codes. Wordblind people can apparently make rapid progress by means of programs where the machine pronounces the (misspelt) words which they then write down.

We also find the combined form appropriate for young people who may have given up a traditional course at school. Young people are already used to this mode of delivery from computer games both at home and wherever they go. For older course participants who may have suffered defeat at school, it is no doubt important that the machine does not "laugh" when they give a wrong answer and that it is extremely patient.

It is, of course, not an area in which we currently have the results of many years of research. Nevertheless, articles and news items are, however, beginning to appear in serious magazines about interactive training programs which have contributed to the very good results of poor spellers, students who have difficulties with elementary arithmetic and so on. There may be both young and adult students. For adults, teaching programs of this kind may help them embark on education for the second time.

A not insignificant side-effect of this form of teaching is no doubt the increased proficiency and confidence of the course participant in relation to new technology. It will be possible to relate this skill to the increasing quantity of information technology which is being used at most workplaces. Here we could point to many mature people with a low level of educational attainment who would no doubt have difficulties in remaining in an increasingly technology-oriented labour market.

Also for young people in the Folkeskole and in post-compulsory education it will be possible to create a greater degree of equal opportunity by means of increased training in the use of new technology as well as by individualising the instruction. There is a correlation between the risk of unemployment, early dropout from education and being parents in social group V, often single parents who are recipients of social benefits. These are also the groups who without doubt will be the last to have technology of this kind in the home, and they will therefore acquire yet another handicap compared with children of parents belonging to higher social groups. They will be even more alienated from technology with which they will be confronted in working life if they are not given the possibility to come to terms with it as a natural part of their education.

Student and teacher roles

4. 7. 3. The pure and simple independent study model makes great demands of the student's self-reliance. It is also a "lonely" model which is probably not to everybody's liking. Apart from this, the model does not actually make great demands. At the same time there is an "element of play" in the work with equipment. Most experience shows that course participants spend a lot of time on a well-organised interactive training program. As with video games and other games, they have a tendency to "keep at it". It is therefore not without reason that the Scandinavian Airlines System has called its interactive continuing training programs "edutainment", i. e. a compound word composed of education and entertainment.

As mentioned in the introduction, some interactive educational programs are still linear, i. e. one starts at the beginning and continues until the course has been completed. Linearity is an increasingly rare occurrence. In most programs, as is the case with books, it is possible to move around, and it will often be possible to choose between several degrees of difficulty in the instruction, too. This feature makes programs well-suited as reference/training tools to which one can return as and when one needs to do so. Such training programs with a high complexity do, of course, require more of the students than simple linear programs.

As opposed to the demands made of the students, interactive training programs also make new demands of the teacher role.

Interactive training programs mark the end of the Danish tradition where the individual teacher is himself responsible for the elaboration of his own teaching materials. The individual professor's practice of writing his own compendium and of lecturing on the basis of it has also come to an end. Such practices have no doubt mainly been based on tradition in higher education. In the Folkeskole and in post-compulsory education, the prevailing tradition has been that lessons are based on textbooks supplemented with other teaching materials - often in the form of photocopies - regardless of whether the course caters for young people or adults. Some of these features are, however, also to be found in multimedia, as the teacher himself can, for instance, decide what the students are to work with on a videodisc and in which order.

The organisation of interactive teaching requires that many kinds of experts work together: experts in the field of the subject-related content, experts in instructional design for this particular medium, computer experts, film people (if new film recordings are included) and last but not least administrators and project management experts who are to ensure that the time schedule is kept and the budget is met.

The more "multimedia-like" the teaching program is, the more experts must be involved. This again means that simpler technologies such as computer-based training can be produced faster and more cheaply than advanced multimedia programs.

It is currently only possible for a very few Danish businesses and educational institutions to cope with large multimedia projects on their own. They have neither the money nor the necessary in-house expertise. This is why the major part of such materials are currently imported from abroad and used in their original form, are purchased and adapted to suit Danish conditions, or developed in a multinational cooperation within the Nordic countries or under the auspices of the EU.

But computer-based training programs are now so simple to develop that in certain circumstances major businesses and institutions could assume responsibility for the development of such programs. There are numerous examples to this effect. Here teachers would have to enter into a cooperation with technicians about the development of programs, and authoring tools are now so good that teachers who have undergone adequate supplementary training would be able to carry out most of the development work.

The teacher roles which remain will be of two kinds. Firstly, acting as a counsellor and providing support in connection with training. In this respect the Danish tradition approaches the British one in which it is normal to differentiate between teacher roles to do with the development of the course and the roles of those who provide support during its implementation.

A second role will be to put together teaching sequences on the basis of a multimedia material as mentioned previously. In most of the more advanced examples of multimedia instructional materials the teacher may himself construct "a path through the material" and, so to speak, build up a lengthy instructional sequence. It presupposes that the teacher masters the medium and knows how to program the sequences.

Choice of technology

4. 7. 4. The technology mix in 1993 for independent study systems may vary considerably. For independent studies at home and in small business, any technology other than the ones mentioned in scenario I is probably unrealistic. It should, however, be noted that the videodisc player is now on its way into the consumer market at prices around 4,000 DKK, and a CD-ROM

drive can be bought for approximately 2,500-3,000 DKK.

This means that major enterprises will no doubt, to a certain degree, change over to a continuing education and training model which in the future will be based on optical disc formats. The lack of completed instructional materials and the costs involved in producing instructional materials on optical media oneself will no doubt mean that in the years to come emphasis will be given to traditional PC-based instructional programs in the form of computer-based training.

The technological sophistication of such courses will thus not be determined by hardware prices but by the lack of software and the costs involved in getting tailor-made instructional products.

It is difficult to guess how fast developments in the independent study area will take place. There is, however, hardly any doubt that we will have a global education and training market in ten years' time where it will be possible to get hold of enormous amounts of education and training courses for independent studies by means of high-speed networks and small work stations offering sound, images, speech, simulations and the like. Many of these materials will no doubt still be in foreign languages, but the development of computer-aided translation programs will no doubt make Danish versions cheaper.

The answer to the question of whether being able to buy international independent study packages at the bookstore and at the local supermarket at special bargain prices will mean that students will choose this rather than a far more expensive direct teaching course lies in the future, and these assumptions are of such a nature that it would not be wise to include them in the scenarios.

4. 7. 5. The independent study model is based on interactive study materials. These may be CBT programs (Computer-Based Training) or multimedia programs. Multimedia programs normally also include "moving" pictures, whereas CBT programs have stills or animation created on the computer. CBT programs may include sound. Multimedia programs normally do have sound.

Independent study programs in principle require that the students are able to work independently with the program without a teacher, and the most important costs are therefore those involved in development and production of the program. For multimedia programs, the costs of players and drives is still so high that only a few homes have sufficiently powerful computers and other peripherals (e. g. a videodisc player) at present. The prices of the hardware needed will, however, fall rapidly and in a few years we will probably be in a situation where equipment for multimedia programs will have entered the home, too.

As this situation is not yet a reality, there is a difference in the basis of the calculations in appendix IV. It has been assumed in the CBT calculations that the students have themselves purchased a computer, whereas for the multimedia calculations it has been assumed that the institution/course provider purchases the equipment. In principle, there is no difference in the implementation of the course, whether it be based on CBT or multimedia programs. So in the following examples, we have only chosen to show the cost structure for CBT programs. As was the case for educational broadcasts, expenses relating to homework, external examiners and administration have not been included, as they would blur the price structure of the medium itself.

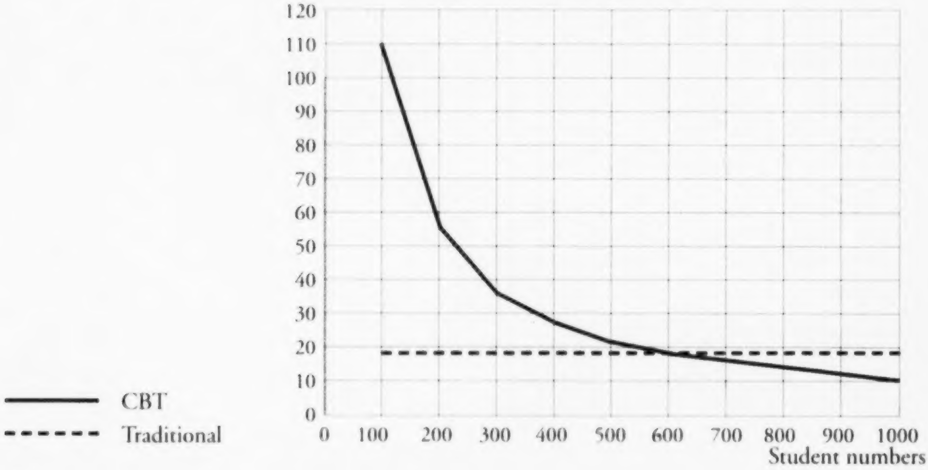
When comparing this mode of delivery with traditional provisions, on the basis of past experience with the use of interactive training programs, the assumption is that study time can be reduced by 33% due to increased learning efficiency. This is, of course, a crucial prerequisite for the comparison.

The most decisive factor for the economics of CBT programs is the number of man-hours spent on the development of a lesson. It is practically impossible to fix a norm for this parameter. It depends on the subject-related content of the course and on the expertise of the course developers as regards programming etc. The quality of the authoring tools used is also of great importance to development time. It is therefore possible to find examples of development time per lesson which vary from 50 hours to as much as 500 hours per lesson.

In the following examples, we have assumed a development time of 100 hours per lesson, cf. the remarks above regarding calculations based on routine operation.

Figure 15 contains a comparison of the unit costs of CBT and traditional provisions per student lesson in 1992.

Figure 15. *Unit costs per student lesson in 1993 for CBT and traditional instruction, respectively.*



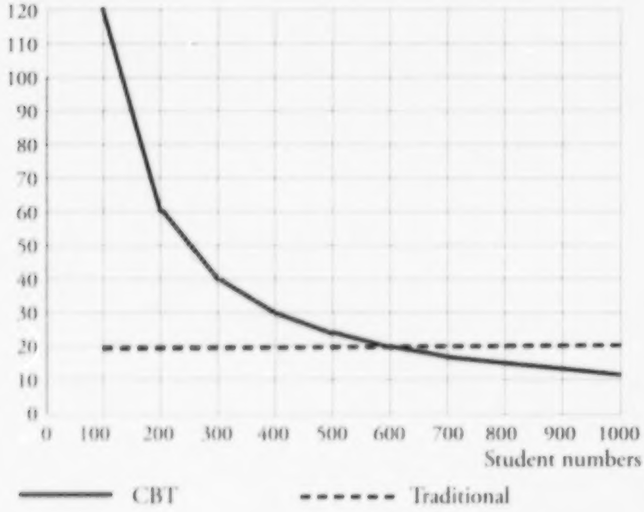
Note: In the traditional provision, as in figure 11, the assumption is that there are 25 students in a class, and that the teacher is an instructor with an hourly wage of 180 DKK and a conversion factor of 2. 5, so that the teacher salary per lesson will be 450 DKK. It has furthermore been assumed that all other costs are identical in the two alternatives and have therefore not been included in the comparison.

It is quite clear that CBT presupposes a significant number of students who are to use the material before it will be economically viable to develop. This may either happen when many students use the material at the same time, or in cases where the material has a long life so that it can be used over several years. Dependent on the price per student lesson in the traditional provision, the CBT model will be economically viable in the range of 500-1000 students, given the prerequisites stated here. Assuming a class size of 25 in the traditional provision, there will be a characteristic horizontal curve showing that unit costs are the same no matter whether 100 or 1000 students are being taught. As opposed to this, the unit costs will fall constantly for the CBT programs, and economies of scale will be obtained for large class sizes.

Interactive teaching materials are often called "electronic books", and it is assumed that a major supply of such programs will gradually appear on the market. Such materials will provide good opportunities of replacing part of traditional provisions with interactive training in cases where the CBT is well-suited pedagogically.

Given that CBT labour costs account for a major part of total costs, in an extrapolation as far as the year 2000 CBT costs will develop almost in parallel to those of traditional provisions. Figure 16 shows the projection as far as the year 2000 compared with traditional provisions. Here costs are based on the same number of development hours as in 1992. Better authoring tools will no doubt contribute to CBT packages being developed in less time in the year 2000 than is the case for 1992 thus leading to a drop in price.

Figure 16. *Unit costs per student lesson for CBT and traditional teaching in year 2000 (DKK at constant 1993 prices).*



Note: *Salaries are forecast to increase by 2% per annum, and teacher salary costs per lesson per student will therefore be DKK 20. 7 in 2000. See moreover the note to figure 15.*

These calculation do not include the economies made in relation to salaries and compensation to course participants which can be obtained by reducing course hours. It is, however, a question of very large amounts which will make the development of CBT programs economically viable with significantly lower numbers of students. The same goes for the use of building capacity. Interactive programs also provide good opportunities to individualise the course. The subsequent effect which is thus the result in the form of a lower dropout rate and/or better quality have not been included in the calculations, either.

CHAPTER 5

The way forward towards the year 2000 - Proposals and recommendations

5. 1. Where do we go from here?

5. 1. 1. In chapter 1, we concluded that major changes could be expected in the education system in the years to come. The need for longer foundation courses of education coupled with the very great need for lifelong continuing education and training will in itself require radical new thinking at many educational institutions. Heterogeneous groups of adults who will move in and out of the system and who quite reasonably will demand that their prerequisites to be taken seriously will account for an increasing proportion of the total education and training capacity of institutions. No matter whether we reorganise the teaching so that it builds on more technology support it will make great demands as to the pedagogical structure of the courses.

It has been said that the organisation of education and instruction is approaching a paradigm shift due to new information technologies. We do not know very much about the consequences they will have, as very little research has been carried out as to what will actually happen to courses and instruction when the computer and networks become common tools for everyone in society. Neither has much research been done in a number of other social areas as to the impact of computers and networks when they become natural parts of everybody's day-to-day life in the entire society. But what we have here is a major problem and it seems clear that we are searching for possible answers.

5. 1. 2. The committee believes that it has given a number of examples of how an increased use of various forms of technology-supported learning could provide good and individualised education and training provisions to a wide variety of groups of adults in search of education and training.

Whether such options would be cheaper than traditional provisions is a debatable issue. It is, however, evident that the very transformation of traditional, direct teaching into technology-supported systems will cost money during the transition phase. A goal-oriented and coordinated effort will therefore be necessary.

The committee believes that it has given a number of examples to the effect that for the rest of the decade the higher rate of increase in the costs of traditional provisions compared with those of technology-supported learning will turn out to be to the decisive advantage of the technology-supported learning model. This is due in particular to documented and anticipated price cuts for the building blocks of the technology-supported learning model, i. e. hardware, software and network services.

A reorganisation may well take place by emphasising modes of delivery which can operate with larger class sizes than is normal in traditional provisions, if possible by coordinating the instruction of small classes, without lowering the quality of the course. Reorganisation may also be effected by replacing part of the traditionally teacher-centred instruction with interactive course materials where the student works on his own and at his own pace. Whether the use of interactive course materials will be economically viable will depend on the total number of students who use them. We anticipate that very large quantities of material of this type will be produced at international level and that a great deal of this could profitably be used in educational contexts in Denmark, too.

5. 1. 3. Falling price trends for the technology-supported learning model, in particular if subjected to market forces, coupled with the natural buoyancy of labour costs for traditional provisions will probably mean that this mode of delivery will become more expensive because there are limits to real productivity gains that can be achieved in such provisions.

5. 1. 4. Whereas the education of young people has traditionally taken place at a number of publicly-financed educational institutions or private institutions with substantial state support, the education of adults has taken place in a far more varied way. We believe that this is a tradition which it is worthwhile preserving and it is our proposal that there should be room for a broad circle of actors when it comes to the provision of formal courses of education for adults.

The whole education and training concept seems likely to undergo a paradigm shift within the next 10-15 years, and we believe that the transition will be fastest if there is free competition and if those taking the initiative can work freely without any stifling bonds of a bureaucratic nature.

This points in the direction of giving more actors engaged in technology-supported learning the opportunity of competing on equal terms. The same applies to the big group of educational suppliers who have in the past delivered traditional education to adults. Both groups possess considerable expertise when it comes to adult pedagogy and the flexible organisation of education for adults.

We therefore recommend that these two groups shall have the opportunity of participating actively in the development of technology-supported learning provisions, including provisions leading to formal educational qualifications. . We imagine that this could become reality by abolishing education and training monopolies and giving all citizens the right to present

themselves for publicly recognised examinations even though they are not enrolled in an educational institution. Public study grants linked to a unit/credit scheme do not seem to constitute an obstacle to a liberalisation which is both characterised by competition and which, at the same time, maintains quality criteria in the form of examinations.

We also see significant opportunities for fruitful cooperation between educational technology specialists, adult and further education, and traditional educational institutions. Such cooperation will increase the pace at which professional expertise in the use of technology support modes of learning is acquired by those offering full-time courses of education.

5. 2. Public educational institutions on the move

The need for continuing education and training

5. 2. 1. Danish experience has shown that there is a considerable need for continuing education and training. International experience also points in this direction. The exposition of Danish experience has shown that adopting an increased use of technology-supported learning is a difficult process for public educational institutions. It has a disturbing effect on the structure of the entire institution. It requires technical understanding and knowledge, it makes new pedagogical and administrative demands. These are rather general requirements with which countries where technology-supported learning is part of everyday life are familiar. But the transfer of experience has so far been poor and has also been of limited value because, when all is said and done, such systems differ and are conditioned by national characteristics.

We therefore propose that an in-service continuing training programme should be initiated for both teachers and administrative staff who are to take part in the organisation and implementation of technology-

supported learning. This programme should be of a temporary nature until existing teacher training provisions have been able to integrate the necessary skills required to offer technology-supported learning programmes. The in-service programme should aim to train a sufficient number of staff in order to establish a core of expertise at the institutions involved; the committee envisages something of the order of 15-20 per cent of the teaching profession taking part in such a course. In the first phase, the target group should be schools of vocational education and training, and institutions of higher education.

It should be a course which covers all categories of teachers. The breadth of the course should be such that it gives an understanding of all the scenarios which have been described in this report, and the course organisation must include practical exercises. The course should be technology-supported in part, so that the course participants have the opportunity to gain first-experience of these study modes.

The development of the course should involve both companies and organisations with experience in technology-supported learning and educational institutions with well-documented expertise in the pedagogical in-service training of the target groups in question.

At the same time, existing teacher training programmes and a number courses in administration should be reorganised so that in initial education and training provisions it becomes possible to acquire professional competence within the area of "organisation of technology-supported learning" in their initial education.

Support for the acquisition of equipment

5. 2. 2. Some technology-supported learning forms require the purchasing of equipment, before the teaching can start. It may be a question of host compu-

142

ters, video-conferencing equipment, special software, the setting up of a network/network nodes as well as the establishment of study centres with equipment for student use. The committee has previously mentioned that in real terms it equates some of these purchases to the building of new premises and the like. It is thus a question of initial expenditure and not operational expenditure. In the present taximeter grant system, obtaining finance for such investments would be difficult because there is as yet limited experience of fitting this type of expenditure into the government appropriations framework. If the responsibility for buildings is delegated to the institutions the purchasing of equipment for technology-supported learning will be at the discretion of the institutions on a par with needs for buildings.

We therefore recommend that funds be earmarked from public building and equipment appropriations for full or partial grants for the purchase of equipment for technology-supported learning. Such grants should only be made for initial purchases.

Financial contributions to operational expenditure for the use of telecommunications and data transmission

5. 2. 3. The very "nervous system" of technology-supported learning systems consists of electronic networks which students and teachers use to talk with each other and which are used for the transmission of pictures, for working with common texts, as a channel for the distribution and delivery of assignments, for literature searches in the library and much, much more. It is probably inconceivable to picture modern technology-supported learning systems without the use of networks, and it is not without reason that they are often referred to as the highways of the information society. But it is not just the physical network which is needed. There are also a number of services attached to the network to ensure its efficient use - and these are often rather expensive.

The committee has indicated above that the relatively high rates of a number of network services will fall significantly in the coming years as a result of technological development and market liberalisation. At the same time, one can expect a trend in the direction of more and more advanced network services on the part of network suppliers.

The entire network issue and the cost structure in this field are however still very vague, and small businesses and institutions without professional experience in the field may risk paying relatively high prices for network services. In the long term, one can assume that free competition will also make itself felt in this area leading to a natural price structure.

We therefore propose a common national network which institutions can join for a limited period of time free of charge, and which provides a series of specific services, including the operation of a conference system or other kinds of electronic systems which facilitate network cooperation among several users. The service should be supported by a unit responsible for service and maintenance,upon which the participating institutions can draw. The operation of the network should be supported by public funds. Support should also be given to students' use inasmuch as they should only have to call the nearest network node and thus pay the local telephone rate.

Increased use of radio/television for educational purposes

5. 2. 4. Recent technological breakthroughs have made it possible for mature media to take on new roles in the future in connection with technology-supported learning.

This for instance applies to the use of television. At the same time existing legislation seems to hold back this development.

We recommend that it should be made possible to use the public broadcasting network for the transmission of educational programmes and data. In addition, the possibility of educational institutions or the Electronic University (see below) using the broadcasting network and retaining intellectual rights to the educational materials themselves should be investigated. It will thus be possible to transmit tapes of non-broadcast video quality, to transmit educational programmes catering for specialised target groups without considering legal editorial matters to do with the balance of output as well as repeats broadcasts as required.

The establishment of a national service centre for the development of technology-supported learning

5. 2. 5. The terms of reference of the committee stipulate that no new institutions offering technology-supported learning only are to be established. The committee is in agreement, and all trends point in the direction that technology-support to varying degrees will become an integral part of most courses within a number of years. It is therefore important that all solutions aim at developing the necessary expertise and professionalism at the institutions as rapidly as possible. The committee has also, however, been able to see that it is a totally new task in most places and that experience is limited and dispersed.

In other countries, too, which chose not to establish new institutions, they have realised that there is a need for a national power house which can inform, disseminate and coordinate, and in general functions as a dynamo which gets things started and sees to it that things are kept on the right track.

We propose that such a centre should also be established in Denmark. In order to guard against the development of an organisation with its own institutional interests, the committee envisages a small organisati-

on along the lines of the Danish Research Academy which could act as a dynamo and function as a source of inspiration. The committee makes the assumption that a considerable part of the tasks will be delegated to the education system. In addition, the centre will be given tasks relating to the drawing up of development contracts, course schedule monitoring, the acquisition of national licences, the importation of foreign teaching materials, copyright issues and the like.

Although we do not feel that it should be an educational institution proper, consideration should be given to the question of letting the centre be responsible for the dissemination of information about, and the organisation of, distance education provisions,in particular those forms corresponding to the time-independent learning model. In this connection, the centre should be entitled to receive government "taximeter" grants (i. e. grants per enrolled student) and subsequently settle accounts with the participating institutions on the basis of contracts entered into.

We imagine that the centre should have a life of ten years. Before this period expires, the future of the centre should be assessed with a view to either closing it down or changing its terms of reference and maintaining it in a scaled down form.

The committee has, somewhat provocatively, called the centre "Den Elektroniske Højskole" (the Electronic University/ Folk High School). The name has been chosen in order to recognise the heritage from Grundtvig and at the same time emphasise that togetherness, closeness and respect for and consideration of the special characteristics of the individual can easily thrive within the framework of a modern information society.

Support, possibly in the form of co-financing, for the reorganisation of a number of courses as technology-supported learning

5. 2. 6. Although we, in our choice of models for technology-supported learning, have taken as our point of departure the fact that Denmark is a small country where it is not possible to get student admissions of many hundred of thousands (or millions) for technology-supported learning, which is the starting point for calculations in other countries, we cannot get around the fact that there is still a need for cooperation regarding the development of study materials and the like, based on the advantages which can be obtained from economies of scale.

When adults choose to organise their education so that it is flexible with regard to time and place, then this choice is normally conditioned by the fact that this very mode of delivery suits their work and family situation best.

We therefore propose that partial or total funding should be made available for the adaptation of a number of traditional courses to include technology-based learning. There should be a broad range of courses organised in this way, to cater for those who would no doubt prefer this delivery mode, if it were generally available.

The aim of supporting such developments, possibly in the form of co-financing agreements, should be to ensure the creation of a broad and coherent educational provision within a period of a few years. This would also enable institutions to offer a wide and varied range of education and training, in particular in the field of formal, vocationally-oriented adult and further education in geographical areas where their location makes it difficult to offer traditional courses.

Appendix 1

THE TERMS OF REFERENCE, COMPOSITION AND CALENDER OF THE COMMITTEE

1. The terms of reference

Terms of reference of the committee on technology-supported learning systems (distance learning)

A number of current or emerging technologies in the market are thought to be well-suited as support for an increased supply of flexible learning which does not presuppose that teachers and students are physically present in the same classroom. Such flexible learning systems are often described under the general heading of distance learning.

The objective of distance learning systems is usually to offer increased flexibility as regards

- distance
- time independence
- access (to the courses in question)
- class sizes (from mass education to geographically-dispersed education and training requirements).

Individual technological aids further this objective to varying degrees. Costs and cost structures and their intrinsic pedagogical qualities vary considerably.

It is the government's view that a possible increased emphasis on distance learning in the education system should not lead to an increase in the total costs of a given educational provision when evaluated over a realistic number of years. The term total costs is thought to cover both the direct costs of education and indirect costs in the form of wage losses/ wage compensation/ production losses/ travel and accommodation expenses and the like.

With this as its point of departure (i. e. budget-neutrality in the short/medium term) and taking into consideration experience gained abroad, the committee is to submit a maximum of 5 scenarios which, when applied individually or jointly, meet the previously-mentioned objective of flexibility as regards time, distance, access and rational class operation. For each model an investment plan and plan of operation shall be drawn up showing the economics of the mode of delivery with various student inputs. Furthermore, pedagogical advantages and disadvantages shall be described for the individual models, as well as the demands made of teacher qualifications compared with those of teachers in traditional classroom instruction.

Emphasis should be given to models deemed to be well-suited for the teaching of adults, and which are presumed to be practicable without the establishment of new educational institutions for distance learning. The need for cooperation and coordination in order to achieve an optimal use of resources should also be described for the individual scenarios.

In the course of its work, the committee may hold one or two seminars with representative groups of interested parties in order to get preliminary feedback about the relative advantages and disadvantages of the scenarios seen in the light of user needs.

The report should be submitted as soon as possible and no later than the summer of 1992. The committee may submit interim reports if this is deemed appropriate.

2. The composition of the committee

The committee had the following composition:

Dorte Olesen, Director
UNI-C, chairman

Hans Siggaard Jensen, Reader
Copenhagen Business School

Annette Lorentsen, Associate professor
Aalborg University Centre

Jens Langeland-Knudsen, Director
CRI (Computer Resources International)

Hanne Shapiro, Consultant
DTI (Danish Technological Institute)

Erling Asmussen, Principal
Holb{k Technical College

Ove Nathan
University of Copenhagen, Rector

Bent Frystyk Nielsen, M. Sc. (Eng.)

Peter Olaf Looms, Consultant
Danmarks Radio, Drive

Niels Geert Bolwig, Associate professor
Aarhus University

Peter Steen Jensen, General inspector of education,
Ministry of Education, appointed as advisor

Lilla Voss, Head of section
Ministry of Education, appointed as advisor

The committee's secretariat consisted of:

Niels Geert Bolwig, Associate professor
Aarhus University (01. 02. 92-30. 06. 93)

Jakob Klingert, Head of finances and human resources
UNI-C

Lilla Voss, Head of section, project manager,
Ministry of Education (1. 1. 92-30. 06. 93)

Rolf Magelund, Head of section
Ministry of Education (1. 1. 92-1. 12. 92)

Karin Dahl Jlrgensen, Head of section
Ministry of Education (1. 1. 92-1. 3. 93)

Kitty Leopold, Assist. head of section
Ministry of Education

Ninna Bay, Assist. head of section
Ministry of Education

Jacob Kerzel Andersen, Student

3. The committee calender

The committee held a total of 14 meetings and 2 seminars (in May 1992 and November 1992) with a representative cross-section of interested parties. The agendas of the seminars appear in appendix 2.

Appendix 2

AGENDAS OF 2 SEMINARS HELD BY THE COMMITTEE WITH THE PARTICIPATION OF A BROAD CROSS-SECTION OF INTERESTED PARTIES

The first Seminar

was held on Friday, 22 May 1992, from 10. 00 to 17. 00 at Hotel Frederiksdal.

The *participants* in the seminar were the invited representatives of interest groups, lecturers and members of the Committee on Technology-Supported Learning Systems and its secretariat.

Programme:

10. 00 - 10. 15:	Welcome by the chairman of the committee, Dorte Olesen.
10. 15 - 11. 00:	Lilla Voss, Open Education, flexible learning modes, trends and perspectives.
11. 00 - 11. 15:	Coffee break.
11. 15 - 12. 00:	Dr. J. H. Hebenstreit, Ecole Superieure d'Electricite, Paris: Trends in the development of technology for flexible learning. (The lecture was held in English).
12. 00 - 13. 00:	Lunch
13. 00 - 13. 45:	Director Chris Curran, National Distance Education Centre, Dublin: Economic Aspects in Distance Learning in Small Countries. (The lecture was held in English).
13. 45 - 15. 30:	Experience from selected Danish models of flexible learning:

a. Business School South: The Diploma Course in applied languages (ED)
b. HAFNIA's CBT model: Incompany training of staff (Inger Marie Dyrberg)
c. Århus Technical College: Production techniques of the 1990s (Jes Kellberg)
d. University of Copenhagen and Danmarks Radio: Mass education via television and radio (Niels Thorsen)
e. DSB In-company training on personal computers with interactive video (Linda Ljungstrøm og Lotte Sørensen).

15. 30 - 15. 45: Coffee break.

15. 45 - 17. 00: Discussion (chairman: Dorte Olesen).

Conclusion.

The **Second** Seminar
was held on Wednesday, 18 November 1992, from 9. 30 to 17. 00 at Gammel Dok.

The *participants* in the seminar were, as was the case with the first seminar, the invited representatives of interested parties and members of the committee and its secretariat.

Programme:

9. 30 - 10. 00:	Arrival/coffee
10. 00 - 10. 05:	Welcome by the chairman of the committee, Dorte Olesen
10. 05 - 11. 15:	Presentation of the scenarios of the committee (the designations are preliminary working titles): 1. The (class-based) asynchronous communication model 2. The study centre model 3. The independent study model
11. 15 - 11. 30:	Coffee break
11. 30 - 12. 20:	Group work, cf. "Proposals for group discussions"
12. 30 - 13. 30:	Lunch
13. 30 - 14. 30:	Continued group work
14. 30 - 15. 15:	Plenary: Presentation of the result of the discussions and points of view of the groups.
15. 15 - 15. 30:	Coffee break.
15. 30 - 17. 00:	Plenary discussion. Conclusion and close.

List of figures

Figure 1. Model of the cost structure for technology-supported learning and traditional educational provisions.

Figure 2. Cost trends for traditional provisions and for manufacturing 1993-2000 (1993=100).

Figure 3. Calculated increase in expenditure for education and training from 1990-2000, given that educational output and educational standards remain unchanged, and that increases in teacher salaries (% per annum) match the national average (Billion DKK at constant 1990 prices).

Figure 4: PC price trends 1986-1993 (DKK, constant 1992 prices)

Figure 5: Modem price trends 1986-1993 (DKK, constant 1992 prices)

Figure 6. Price trends for selected software packages 1987-1993 (DKK, in constant 1992 prices)

Figure 7. Graphic representation of the relationship between technology, pedagogy, organisation and economics

Figure 8. Advantages and disadvantages of selected modes of delivery

Figure 9. Costs per student in 1992 for the ED-programme of various class sizes and different modes of delivery

Figure 10. Comparison of unit costs in 1992 and in the year 2000. The costs for both the computer conference model and the traditional provision are expressed in constant 1992 prices

Figure 11. Unit costs per lesson for educational broadcasts in 1992 and in year 2000 compared with traditional provisions

Figure 12. Unit costs in DKK in 1992 of one educational programme with transmission costs of 500, 1,000 and 10,000 DKK per programme and the distribution of materials 4 times

Figure 13. Unit costs per lesson in 1992 for the higher commercial examination course when organised in the traditional way and by means of video-conferencing.

Figure 14. Unit costs per lesson in the year 2000 when organising the higher commercial examination course traditionally and by means of video-conferencing

Figure 15. Unit costs per student lesson in 1993 for CBT and traditional instruction, respectively.

Figure 16. Unit costs per student lesson for CBT and traditional teaching in year 2000 (DKK at constant 1993 prices).

List of tables

Table 1. Distribution of public expenditure for education and training 1982-1991 by levels of education. All figures are in billion DKK at constant 1991 prices.

Table 2. The percentage share of public operational expenditure accounted for by salaries in different sectors of the education system in 1990.

Table 3. PC price trends 1986-1993 (DKK, constant 1992 prices)

Table 4: Modem price trends 1986-1993 (DKK, constant 1992 prices)

Table 5. Price trends for multimedia hardware1986-93 (DKK, in constant 1992 prices)

Table 6. Price trends for selected software packages 1987- 1993 (DKK, in constant 1992 prices)

Table 7. Hourly ISDN-2 telephone rates for selected regions/countries in 1993

Table 8. Annual savings in costs per student in DKK for the higher commercial examination course with 26 students at the main centre when choosing video-conferencing rather than the traditional provision

Undervisnings
ministeriet

BEST COPY AVAILABLE